SATELLINE®-3AS NMS
SATELLINE®-3AS NMS Epic
SATELLINE®-3AS NMS 869
SATELLINE®-3AS VHF

Radio Data Modems

USER GUIDE

Version 1.0

SATEL

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Salo, FINLAND 2006

RESTRICTIONS ON USE

SATELLINE-3AS(d) NMS family radio modems have been designed to operate on frequency ranges, the exact use of which differs from one region and/or country to another. The user of a radio modem must take care that the said device is not operated without the permission of the local authorities on frequencies other than those specifically reserved and intended for use without a specific permit.

SATELLINE-3AS(d) NMS (380…470 MHz) is allowed to be used in the following countries, either on licence free channels or on channels where the operation requires a licence. More detailed information is available at the local frequency management authority.

Countries*: AT, AU, BE, BR, CA, HR, CZ, CY, DK, EE, FI, FR, DE, GR, HK, HU, IN[*1], ID, IS, IE, IL, IT, KR[*2], KZ, LV, LT, MT, MY, MX, NL, NO, PL, PT, RO, RU, SG, SK, SI, ZA, ES, SE, CH, TH, TR, TW[*1], UA, GB, US and VN

SATELLINE-3AS(d) NMS Epic (380…470 MHz) is allowed to be used in the following countries, either on licence free channels or on channels where the operation requires a licence. More detailed information is available at the local frequency management authority.

Countries*: AT, AU, BE, CA, HR, CZ, DK, EE, FI, FR, DE, GR, HU, IN[*1], ID, IS, IE, IL, IT, KZ, LV, LT, MT, MY, NL, NO, PL, PT, RO, RU, SK, ZA, ES, SE, CH, TH, TR, TW[*1], UA, GB, US and VN

SATELLINE-3AS(d) NMS 869 is designed to operate in the following countries listed below on the licence free frequency band of 869.400 – 869.650 MHz (not incorporating the band 869.300 – 869.400 MHz) according to recommendation CEPT/ERC/REC 70-03. This recommendation has been drawn up by the European Radio communications Committee (ERC) under CEPT. The transmit/receive duty cycle of the individual unit is limited to 10% on this band, and a single transmission period must not exceed 36 s. In addition, the maximum allowed radiated output power is 500 mW_{ERP}. The duty cycle limitation is to be controlled by the terminal equipment connected to the radio modem. The radio modem does not limit the duty cycle.

Countries*: AT, BE, CZ, CY, DK, EE, FI, FR, DE, GR, HR, HU, IS, IE, IT, LV*[3], MT, NL, NO, PL, PT, SI, SK, ES, SE, CH, TR and GB

* Codes of the countries follow the ISO 3166-1-Alpha-2 standard

[*1] Project approval to be applied case-by-case

[*2] Special versions only for Korea available

*[3] Max. ERP 10 mW

WARNING! Users of SATELLINE-3AS(d) NMS radio modems in North America should be aware, that due to the allocation of the frequency band 406.0 – 406.1 MHz for government use only, the use of radio modem on this frequency band without a proper permit is strictly forbidden.

PRODUCT CONFORMITY

SATELLINE-3AS(d) NMS

Hereby, SATEL Oy declares that SATELLINE-3AS(d) NMS radio modem is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC. Therefore the equipment is labelled with the following CE-marking. The notification sign informs user that the operating frequency range of the device is not harmonised throughout the market area, and the local spectrum authority should be contacted before the usage of the radio modem.

CE 0523 !

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LOCAL AREA WIRELESS DATA COMMUNICATIONS

DECLARATION of CONFORMITY

In Accordance with

1999/5/EC Directive

of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

Doc No: SATEL-DC-RTTE-051

Manufacturer: SATEL Oy

Address: POB 142, (Meninitynkatu 17), 24101 Salo, Finland

Products :

Type	Model
SATELLINE-3AS/125 **SATELLINE-3AS/200** **SATELLINE-3AS/250**	**SATELLINE-3AS** Radio Modem **SATELLINE-3AS NMS** Radio Modem
SATELLINE-3ASd/125 **SATELLINE-3ASd/200** **SATELLINE-3ASd/250**	**SATELLINE-3ASd** Radio Modem **SATELLINE-3ASd NMS** Radio Modem
SATELLINE-3AS-PT/125 **SATELLINE-3AS-PT/200** **SATELLINE-3AS-PT/250**	**SATELLINE-3AS-PT** Radio Modem
SATELLINE-3AS-AG/125 **SATELLINE-3AS-AG/200** **SATELLINE-3AS-AG/250**	**SATELLINE-3AS-AG** Radio Modem

Notified Body Opinion: according to: Annex IV of R&TTE Directive
Document Nr: FI05700042
Issued by: Finnish Communications Regulatory Authority
Dated On: 20th of December, 2005
Notified Body Nr. 0523

We, the manufacturer of the above mentioned products, hereby declare that these products conform to the essential requirements of the European Union directive 1999/5/EC. This Declaration of Conformity is based on the following documents:

Doc. No	Type of Product	Test Specification	Laboratory / Date of Issue
TL 990313	-3ASd/125	ETS 300 113	EMCEC / Espoo 29.02.2000
TL 1000461	-3ASd/250	ETS 300 113	EMCEC / Espoo 29.02.2000
TL 980212	-3ASd/250	EN 300 220-1	EMCEC / Espoo 07.10.1998
200212216	-3ASd/125	IEC 60950 3rd Ed 1999	NEMKO / Oslo 22.03.2002
200212216	-3ASd/250	IEC 60950 3rd Ed 1999	NEMKO / Oslo 22.03.2002
1031925	-3ASd/250	EN 301 489-1,-5	NEMKO / Espoo 30.10.2003
1032532	-3ASd/200	EN 300 113-2	NEMKO / Espoo 23.11.2004

Based on the fact that the technical requirements have not changed between the standards ETS 300 113 and EN 300 113-2, as well as EN 300 220-1 and -3, we therefore declare the full conformity to the standards EN 300 113-2 and EN 300 220 -3.

Salo on 6th of June, 2006

SATEL OY

Pekka Aura
Managing Director

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SATELLINE-3AS(d) NMS Epic (C)

Hereby, SATEL Oy declares that SATELLINE-3AS(d) NMS Epic (C) radio modem is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC. Therefore the equipment is labelled with the following CE-marking.

CE 0523 !

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LOCAL AREA WIRELESS DATA COMMUNICATIONS

DECLARATION of CONFORMITY

In Accordance with

1999/5/EC Directive

of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

Doc No: SATEL-DC-RTTE-053

Manufacturer: SATEL Oy

Address: POB 142, (Meriniitynkatu 17), 24101 Salo, Finland

Products :

Type	Model
SATELLINE-3AS/125/10W/DIV	**SATELLINE-3AS Epic** Radio Modem **SATELLINE-3AS Epic C** Radio Modem
SATELLINE-3AS/250/10W/DIV	**SATELLINE-3AS NMS Epic** Radio Modem **SATELLINE-3AS NMS Epic C** Radio Modem
SATELLINE-3ASd/125/10W/DIV	**SATELLINE-3ASd Epic** Radio Modem **SATELLINE-3ASd Epic C** Radio Modem
SATELLINE-3ASd/250/10W/DIV	**SATELLINE-3ASd NMS Epic** Radio Modem **SATELLINE-3ASd NMS Epic C** Radio Modem

Notified Body Opinion: according to: Annex IV of R&TTE Directive
Document Nr: FI02700011
Issued by: Finnish Communications Regulatory Authority
Dated On: 8th of April, 2002
Notified Body Nr. 0523

We, the manufacturer of the above mentioned products, hereby declare that these products conform to the essential requirements of the European Union directive 1999/5/EC. This Declaration of Conformity is based on the following documents:

Doc. No	Type of Product	Test Specification	Laboratory / Date of Issue
TL 1010749	SATELLINE-3ASd/125/10W/DIV	EN 300 113-1	EMCEC / Espoo 27.2.2001
TL 1010876	SATELLINE-3ASd/250/10W/DIV	EN 300 113-1	EMCEC / Espoo 27.8.2001
TL 1010750	SATELLINE-3ASd/125/10W/DIV	ETS 300 279	EMCEC / Espoo 28.02.2001
200212274	SATELLINE-3ASd/125/10W/DIV	IEC 60950	NEMKO / Oslo 22.3.2002
200212274	SATELLINE-3ASd/250/10W/DIV	IEC 60950	NEMKO / Oslo 22.3.2002

Based on the fact that the technical requirements have not changes between the standards ETS 300 113 and EN 300 113-2 we therefore declare the full conformity to the standard EN 300 113-2.

Salo on 6th of June, 2006

SATEL OY

Pekka Aura
Managing Director

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SATELLINE-3AS(d) NMS 869

Hereby, SATEL Oy declares that SATELLINE-3AS(d) NMS 869 radio modem is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC. Therefore the equipment is labelled with the following CE-marking.

CE 0523 !

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LOCAL AREA WIRELESS DATA COMMUNICATIONS

DECLARATION of CONFORMITY

In Accordance with

1999/5/EC Directive

of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

Doc No:	SATEL-DC-RTTE-052
Manufacturer:	SATEL Oy
Address:	POB 142, (Meriniitykatu 17), 24101 Salo, Finland

Products :

Type	Model
SATELLINE-3AS/869	**SATELLINE-3AS 869** Radio Modem **SATELLINE-3AS 869 NMS** Radio Modem
SATELLINE-3ASd/869	**SATELLINE-3ASd 869** Radio Modem **SATELLINE-3ASd 869 NMS** Radio Modem

Notified Body Opinion:

according to:	Annex IV of R&TTE Directive
Document Nr:	FI03700002
Issued by:	Finnish Communications Regulatory Authority
Dated On:	7th of February, 2003
Notified Body	Nr. 0523

We, the manufacturer of the above mentioned products, hereby declare that these products conform to the essential requirements of the European Union directive 1999/5/EC. This Declaration of Conformity is based on the following documents:

Doc. No	Type of Product	Test Specification	Laboratory / Date of Issue
TL 1000553	-3ASd/869	EN 300 220-1	EMCEC / Espoo 23.08.2000
200212216	-3AS(d)/869	IEC 60950 3rd Ed 1999	NEMKO / Oslo 22.03.2002
1031926	-3AS(d)/869	EN 301 489-1,-3	NEMKO / Espoo 30.10.2003

Based on the fact that the technical requirements have not changes between the standards EN 300 220-1 and -3, we therefore declare the full conformity to the standard 300 220-3.

Salo on 6th of June, 2006.

SATEL OY

Pekka Aura
Managing Director

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SATELLINE-3AS(d) VHF

Hereby, SATEL Oy declares that SATELLINE-3AS(d) VHF radio modem is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC. Therefore the equipment is labelled with the following CE-marking.

CE 0523 !

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LOCAL AREA WIRELESS DATA COMMUNICATIONS

DECLARATION of CONFORMITY

In Accordance with

1999/5/EC Directive

of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

Doc No: SATEL-DC-RTTE-050
Manufacturer: SATEL Oy
Address: POB 142, (Mennitynkatu 17), 24101 Salo, Finland

Products :	Type	Model
	SATELLINE-3AS/VHF/125 **SATELLINE-3AS/VHF/250**	**SATELLINE-3AS VHF** Radio Modem
	SATELLINE-3ASd/VHF/125 **SATELLINE-3ASd/VHF/250**	**SATELLINE-3ASd VHF** Radio Modem
	SATELLINE-3AS/VHF/C/125 **SATELLINE-3AS/VHF/C/250**	**SATELLINE-3AS VHF C** Radio Modem
	SATELLINE-3ASd/VHF/C/125 **SATELLINE-3ASd/VHF/C/250**	**SATELLINE-3ASd VHF C** Radio Modem

Notified Body Opinion: according to: Annex IV of R&TTE Directive
Document Nr: FI06700007
Issued by: Finnish Communications Regulatory Authority
Dated On: 16th of May, 2006
Notified Body Nr. 0523

We, the manufacturer of the above mentioned products, hereby declare that these products conform to the essential requirements of the European Union directive 1999/5/EC. This Declaration of Conformity is based on the following documents:

Doc. No	Type of Product	Test Specification	Laboratory / Date of Issue
62647	-3AS/VHF/C/125	EN 300 113-2 (v1.3.1)	NEMKO / Espoo 03.03.2006
59818	-3ASd/VHF/C/250	EN 300 113-2 (v1.3.1)	NEMKO / Espoo 24.02.2006
59818 EMC	-3ASd/VHF/C/250	EN 301 489-1 (v.1.5.1), EN 301 489-5 (v.1.3.1)	NEMKO / Espoo 13.01.2006
65867	-3ASd/VHF/C/	EN 60950-1	NEMKO / Espoo 10.05.2006

Salo on 15th of June, 2006

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WARRANTY AND SAFETY INSTRUCTIONS

Read these safety instructions carefully before using the product:

- Warranty will be void, if the product is used in any way that is in contradiction with the instructions given in this manual, or if the radio modem housing has been opened or tampered with.

- The radio modem is only to be operated at frequencies allocated by local authorities, and without exceeding the given maximum allowed output power ratings. SATEL and its distributors are not responsible, if any products manufactured by it are used in unlawful ways.

- The devices mentioned in this manual are to be used only according to the instructions described in this manual. Faultless and safe operation of the devices can be guaranteed only if the transport, storage, operation and handling of the devices are appropriate. This also applies to the maintenance of the products.

- To prevent damage both the radio modem and any terminal devices must always be switched OFF before connecting or disconnecting the serial connection cable. It should be ascertained that different devices used have the same ground potential. Before connecting any power cables the output voltage of the power supply should be checked.

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1 INTRODUCTION

SATEL Oy is a Finnish electronics and Telecommunications Company specialising in the design and manufacture of wireless data communication products. SATEL designs, manufactures and sells radio modems intended for use in applications ranging from data transfer to alarm relay systems. End users of SATEL products include both public organisations and private individuals.

SATEL is the leading European manufacturer of radio modems. SATEL radio modems have been certified in most European countries and also in many non-European countries.
SATELLINE-3AS(d) NMS family of radio modems provide the Network Management System (NMS) feature together with an advanced flexibility to connect it to a wide variety of terminal equipment, making it an ideal solution in many wireless data communication applications.
The members of the SATELLINE-3AS(d) NMS product family are SATELLINE-3AS(d) NMS, SATELLINE-3AS(d) NMS Epic, SATELLINE-3AS(d) NMS 869 and SATELLINE-3AS(d) VHF radio modems.
The key features include:

- Network Management System – easy to use design & maintenance tools
- Half duplex radio data transfer
- Frequency variants:
    - 138...174 and 218…238 MHz (SATELLINE-3AS VHF)
    - 380…470 MHz (SATELLINE-3AS(d) NMS)
    - 400 … 470 MHz (SATELLINE-3AS(d) NMS Epic)
    - 869 MHz licence free frequency band (SATELLINE-3AS NMS 869)
- RS232/485/422 serial interface at 1200…38 400 bps data rates
- Over-the-air data rate:
    - 9600 bps @ 12,5 channel spacing
    - 19200 bps @ 25 channel spacing
- Power level of the transmitter:
    - 10 mW…1W (SATELLINE-3AS(d) NMS)
    - 10 mW … 500 mW (SATELLINE-3AS(d) NMS 869)
    - 1 W…10 W (SATELLINE-3AS(d) NMS Epic)
    - 100 mW…5 W (SATELLINE-3AS VHF)
    - It is possible to reach distances up to 50 km depending on topographic conditions and antenna arrangements.
- LCD display and 4 push buttons
    - Easy configuration, no need to use external terminal unit to change the basic settings
    - Monitoring of the signal level (RSSI) and the voltage of the power supply.
- LED indicators show the status of the interface signals.
- Routing/repeater functions
- Packet filter features provide a flexible interface to different data protocols.
- Error correction (FEC)
- Error detection
- External command language (Extended SL commands)
- OEM versions available

Typical applications of SATELLINE-3AS(d) NMS radio modems include:

- Replacing cables in cases where installation of a cable is difficult or expensive
- Data transmission to/from mobile or portable terminals
- Telemetry
- Remote control and alarm transmission
- GPS-applications
- etc.

1.1 NOTES FOR THE USERS OF SATELLINE-3AS(d) RADIO MODEMS

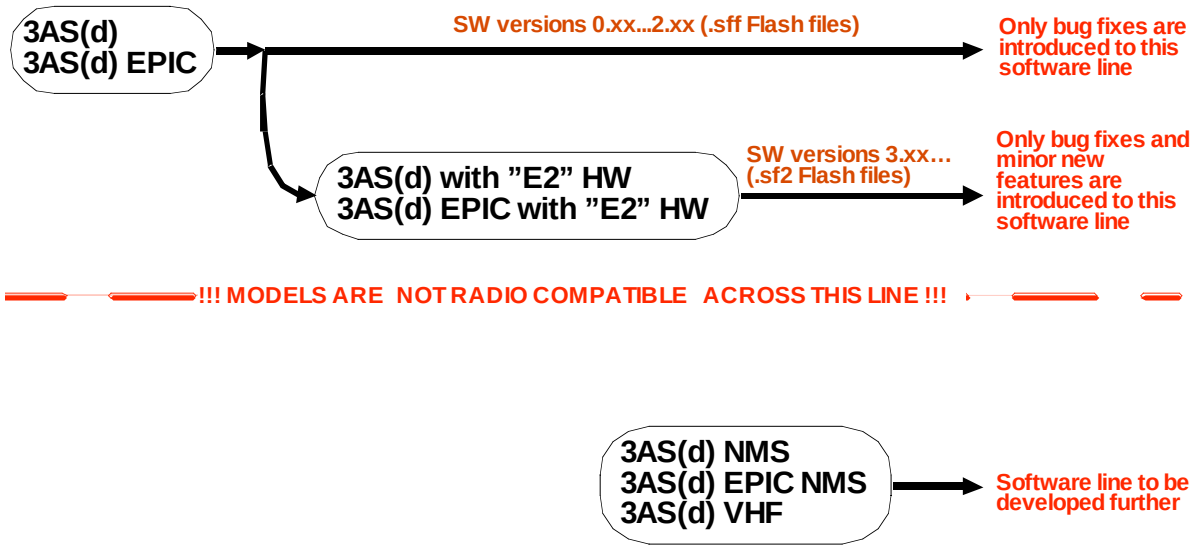
SATELLINE-3AS(d) NMS / NMS Epic / NMS 869 / VHF radio modems are NOT COMPATIBLE WITH SATELLINE-3AS radio modems!

In order to help users to identify the differences in the operation of these products there are notices among the text marked by the symbol on the left.

DIFFERENCES OF SATELLINE-3AS(d) NMS / NMS Epic / NMS 869 / VHF compared to SATELLINE-3AS(d):

- NMS (Network Management System) features
- Radio messages NOT compatible
- Slightly different timing in the data transfer. NMS overhead is typically 20 … 60 bytes per a radio transmission.
- 3AS NMS family products have a completely new setup system
- Error detection improved (Partial/Full)
- Packet filters, adjustable Packet pause length and other enhancements enable better connectivity to customer systems and protocols
- RX/TX addresses are NOT supported, they are replaced by the NMS routing scheme
- 9-bit serial data is NOT supported
- DTR pin control modified

COMPATIBILITY CHART OF SATELLINE-3AS(d) and SATELLINE-3AS(d) NMS RADIO MODEMS


3AS(d)
3AS(d) EPIC
SW versions 0.xx...2.xx (.sff Flash files)
Only bug fixes are introduced to this software line
3AS(d) with "E2" HW
3AS(d) EPIC with "E2" HW
SW versions 3.xx... (.sf2 Flash files)
Only bug fixes and minor new features are introduced to this software line
!!! MODELS ARE NOT RADIO COMPATIBLE ACROSS THIS LINE !!!
3AS(d) NMS
3AS(d) EPIC NMS
3AS(d) VHF
Software line to be developed further

1.2 PC PROGRAMS TO BE USED WITH SATELLINE-3AS NMS FAMILY

***SATEL NMS PC* software is required in order to use the NMS features of SATELLINE-3AS NMS radio modem family. It is also required if you want to modify the NMS routing or protocol related parameters of the SATELLINE-3AS NMS family.** SATEL NMS PC provides the management tools for designing, configuring and controlling the SATELLINE-3AS NMS network. The program is compatible with Microsoft Windows 2000® and Microsoft Windows XP® operating systems. See the chapter "3 *NMS - NETWORK MANAGEMENT SYSTEM* "for more information.

***SATERM LITE* is the terminal software that is recommended in order to modify the settings of SATELLINE-3AS NMS family radio modem through the *Programming menu*.** SATERM LITE is software designed by SATEL Oy to assist in the basic configuration and testing of the radio modems manufactured by SATEL Oy. The program is compatible with Microsoft Windows 2000® and Microsoft Windows XP® operating systems. It includes the terminal window and additional features like time stamping, transmission of special character strings, ASCII and hexadecimal presentation of characters etc.
Almost any other terminal program e.g. HyperTerminal can be utilized for the use of the *Programming menu*, but *SATERM LITE* provides additional, useful functions for testing and monitoring of serial data.

***NOTE!* DO NOT USE *SATERM* WITH SATELLINE-3AS NMS family!**
The reason for this is that the project files or the graphical network design tool in the Message Routing setup of *SATERM* do NOT support SATELLINE-3AS NMS radio modems.
Instead, the network drawing tools for SATELLINE-3AS NMS are included in the *SATEL NMS PC*.

***Flash update*: Reprogramming the actual firmware of the radio modem is performed by running the appropriate .exe file (for PC) that includes the desired version of the radio modem software. The radio modem must be in the *Programming Mode* while performing the flash update procedure.**
For example, SATELLINE_3AS_NMS_sw_4_1_2.exe is the software file for updating the software version 4.1.2 in the SATELLINE-3AS(d) NMS radio modems.

2 SATELLINE-3AS(d) NMS / NMS Epic / NMS 869 / VHF RADIO DATA MODEMS

2.1 SATELLINE-3AS(d) NMS Technical specifications (380...470 MHz)

SATELLINE-3AS(d) NMS (380…470 MHz) comply with the following international standards: EN 300 113-1,-2, EN 301 489-1,-5, IEC 60950 and FCC CFR47 part 90.
In addition it meets the EN 300 220-1,-3 with 25 kHz channel spacing.

RADIO TRANSCEIVER	
Frequency Range	380...470 MHz
Channel Spacing	12.5 / 20 / 25 kHz
Number of Channels	160 / 100 / 80 or (2 x 160 / 2 x 80) **Note 1*
Frequency Stability	< ± 1.5 kHz
Type of Emission	F1D
Communication Mode	Half-Duplex
RADIO TRANSMITTER	
Carrier Power	10 mW ... 1 W / 50 Ω
Carrier Power Stability	+ 2 dB / - 3 dB
Adjacent Channel Power	according to EN 300 220-1/EN 300 113-1
Spurious Radiation	according to EN 300 220-1/EN 300 113-1
RADIO RECEIVER	
Sensitivity	- 115... –110 dBm (BER < 10 E-3) **Note 2*
Common Channel Rejection	> - 12 dB
Adjacent Channel Selectivity	> 60 dB @ 12,5 kHz, > 70 dB @ 25 kHz
Intermodulation Attenuation	> 65 dB
Spurious Radiation	< 2 nW
MODEM	
Interface level	RS-232, RS-485, RS-422
Interface	One port for data and one for NMS
Interface Connector	D15, female
Data Speed of Serial Interface	1200 – 38400 bps
Data Speed of Radio Interface	19200 bps (25 kHz channel) 9600 bps (12.5 and 20 kHz channel)
Data format	Asynchronous data
GENERAL	
Operating Voltage	+ 9 ...+ 30 V_{DC}
Power Consumption (average)	1.4 VA (Receive), 6.0 VA (Transmit) 0.05 VA (in *Standby Mode*)
Operating Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 Ω, female
Housing	Aluminium enclosure
Size H x W x D	137 x 67 x 29 mm
Installation Plate	130 x 63 x 1 mm
Weight	250 g

* *Note 1*: The Dual Band versions operate on two separate 2 MHz wide frequency bands.
* *Note 2:* Depending on Receiver settings

2.2 SATELLINE-3AS(d) NMS Epic Technical specifications

SATELLINE-3AS(d) NMS Epic (400…470 MHz) comply with the following international standards: EN 300 113-1,-2, EN 301 489-1,-5, IEC 60950 and FCC CFR47 part 90.

RADIO TRANSCEIVER	
Frequency Range	400...470 MHz
Channel Spacing	12.5 / 20 / 25 kHz
Number of Channels	160 / 100 / 80 or (2 x 160 / 2 x 80) **Note 1*
Frequency Stability	< ± 1.5 kHz
Type of Emission	F1D
Communication Mode	Half-Duplex
RADIO TRANSMITTER	
Carrier Power	1 W, 2 W, 5 W, 10 W / 50 Ω
Carrier Power Stability	+ 2 dB / - 3 dB
Adjacent Channel Power	according to EN 300 113-1
Spurious Radiation	according to EN 300 113-1
RADIO RECEIVER	
Sensitivity	- 115... –110 dBm (BER < 10 E-3) **Note 2*
Common Channel Rejection	> - 12 dB
Adjacent Channel Selectivity	> 60 dB @ 12.5 kHz, > 70 dB @ 25 kHz
Intermodulation Attenuation	> 65 dB
Spurious Radiation	< 2 nW
Diversity	Space diversity
MODEM	
Interface level	RS-232, RS-485, RS-422
Interface	One port for data and one for NMS
Interface Connector	D15, female
Data Speed of Serial Interface	1200 – 38400 bps
Data Speed of Radio Interface	19200 bps (25 kHz channel) 9600 bps (12.5 / 20 kHz channel)
Data format	Asynchronous data
GENERAL	
Operating Voltage	+ 11.8 ...+ 30 V_{DC}
Power Consumption (average)	3 VA (Receive), 33 VA (Transmit) 0.1 VA (in *Standby Mode*)
Operating Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 Ω, female
Housing	Aluminium enclosure
Size H x W x D	154 x 123 x 29 mm without cooling part 154 x 151 x 77 mm with cooling part 130 x 63 x 1 mm
Installation Plate	
Weight	580 g without cooling part 1480 g with cooling part

* *Note 1*: The Dual Band versions operate on two separate 2 MHz wide frequency bands.
* *Note 2:* Depending on Receiver settings

2.3 SATELLINE-3AS(d) NMS 869 Technical specifications

SATELLINE-3AS(d) NMS 869 comply with the following international standards:
EN 300 220-1,-3, EN 301 489-1,-3 and IEC 60950.

RADIO TRANSCEIVER	
Frequency Range	869.400 ... 869.650 MHz
Channel Spacing	25 kHz
Number of Channels	10
Frequency Stability	< ± 2.5 kHz
Type of Emission	F1D
Communication Mode	Half-Duplex
RADIO TRANSMITTER	
Carrier Power	10 mW...500 mW / 50 Ω
Carrier Power Stability	+ 2 dB / - 3 dB
Adjacent Channel Power	according to EN 300 220-1
Spurious Radiation	according to EN 300 220-1
RADIO RECEIVER	
Sensitivity	-108 dBm (BER < 10 E-3) *
Common Channel Rejection	> - 12 dB
Adjacent Channel Selectivity	> 60 dB
Intermodulation Attenuation	> 60 dB
Spurious Radiation	< 2 nW

MODEM	
Interface	RS-232 or RS-485, RS-422
Interface Connector	D15, female
Data speed of RS-Interface	1200 – 38400 bps
Data speed of Radio Interface	19200 bps
Data format	Asynchronous RS-232 or RS-422 or RS-485

GENERAL	
Operating Voltage	+ 9 ...+ 30 V_{DC}
Power Consumption (average)	1.7 VA (Receive) 4.0 VA (Transmit) 0.05 VA (in *Standby Mode*)
Operating Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 Ω, female
Housing	Aluminium enclosure
Size H x W x D	137 x 67 x 29 mm
Installation Plate	130 x 63 x 1 mm
Weight	250 g

* Depending on Receiver settings

2.4 SATELLINE-3AS(d)VHF Technical specifications

SATELLINE-3AS(d) VHF complies with the following international standards:
EN 300 113-1,-2*[1], EN 301 489-1,-5, IEC 60950-1 and FCC CFR47 part 90.

RADIO TRANSCEIVER	
Frequency Range	138...174 MHz (138…160 and 155…174 MHz variants) 218…238 MHz
Channel Spacing	12.5 / 25 kHz
Number of Channels	1600 / 800
Frequency Stability	< ± 650 Hz
Type of Emission	F1D
Communication Mode	Half-Duplex
RADIO TRANSMITTER	
Carrier Power	100 mW, 500 mW, 1 W, 5 W / 50 Ω
Carrier Power Stability	+ 1.5 dB / - 1.5 dB
Adjacent Channel Power	according to EN 300 220 / EN 300 113 and CRF47 part90
Spurious Radiation	according to EN 300 220 / EN 300 113
RADIO RECEIVER	
Sensitivity	- 115... –110 dBm (BER < 10 E-3) *[2]
Common Channel Rejection	> -12 dB
Adjacent Channel Selectivity	> 50 dB @ 12,5 kHz, > 60 dB @ 25 kHz
Intermodulation Attenuation	> 60 dB
Spurious Radiation	< 2 nW
MODEM	
Interface level	RS-232 or RS-485, RS-422
Interface	One port for data and one for NMS
Interface Connector	D15, female
Data Speed of Serial Interface	1200 – 38400 bps
Data Speed of Radio Interface	19200 bps (25 kHz channel) 9600 bps (12.5 kHz channel)
Data format	Asynchronous data
GENERAL	
Operating Voltage	+ 8 ...+ 30 V_{DC}
Power Consumption (average)	1.7 VA (Receive), 6.6 VA (Transmit at 1W) 0.07 VA (in *Standby Mode*)
Operating Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 Ω, female
Housing	Aluminium enclosure
Size H x W x D	137 x 67 x 29 mm without a heat sink
Installation Plate	137 x 80 x 56 mm with a heat sink 130 x 63 x 1 mm
Weight	265 g without a heat sink 550 g with heat sink

*[1] Full compliance with the Tx parameter limits. Please refer to specifications above for minor deviations from Rx parameter limits.

*[2] Depending on Receiver settings

2.5 Order information

In order to ensure the correct deliveries of SATELLINE-3AS(d) NMS radio modems, the customer should specify the information listed below in the order form.

The following information MUST be provided in the order form:

1. General

- Name and the SATEL code of the radio modem
- Quantity of the items
- Company name, delivery address, telephone / fax number and contact person
- Purchase order number
- Date of the order
- Country of destination

2. Radio frequency information

- Operating frequency or limits of the required frequency bands (refer to the table below)
- Channel spacing (25, 12.5 or 20 kHz)

Table 2.1. **Available RF bands of SATELLINE-3AS NMS / NMS Epic / NMS 869 / VHF**

Product variant	*Frequency bands available*	*Channel spacing available*
SATELLINE-3AS(d) NMS	380–470 MHz *Note:* the tuning range of SATELLINE-3AS NMS is ±1MHz from the nominal center frequency.	12.5 kHz / 20 kHz / 25 kHz
SATELLINE-3AS(d) NMS Epic	400-470 MHz *Note:* the tuning range of SATELLINE-3AS NMS Epic is ±1MHz from the nominal center frequency.	12.5 kHz / 20 kHz / 25 kHz
SATELLINE-3AS(d) NMS 869	869.400 - 869.650 MHz (License exempt 500 mW sub-band)	25 kHz only
SATELLINE-3AS(d) VHF	138–174 MHz and 218-238 MHz *Note:* the tuning range covers the whole radio board range (138 – 160, 155 – 174 or 218 – 238 MHz)	12.5 kHz / 25 kHz

Note1: The radio modem is shipped with all the other settings according the default setup, unless otherwise specifically ordered. See the next chapter for the default settings.

Note2: The regulations set by the local authorities must be taken into account in the use of the radio frequency bands!

3. Order for possible accessories (antennas, cables, adapters, filters)

2.6 Settings

The snapshot of the *Programming menu* below presents the default setup of SATELLINE-3AS NMS / NMS Epic / NMS 869 / VHF radio modems.

```
--------------------------------------------------------------------------------
    SATELLINE-3ASd NMS
    SW: version_info_of_the_software_comes_here
    HW: version_info_of_the_hardware_comes_here
    RF: version_info_of_the_radio_module_comes_here
    Center frequency xxx.xxxxxx MHz / Channel spacing xx.xxx kHz
    SERIAL: xxxxxxxxxx  Name: Modem_Name
--------------------------------------------------------------------------------

1 ) Radio Settings      TX frequency: nnn.nnnnnn MHz / TX Power 1 W
                        RX frequency: nnn.nnnnnn MHz / FEC OFF /
                        RSSI Threshold -112 dBm / Error check OFF
                        TX delay 0 ms / Sync interval default
2 ) Network Mode        Basic - TX Priority
3 ) Serial Port 1       DATA / RS232 / 19200 bps / 8 bit data / None parity /
                        1 stop bit
4 ) Serial Port 2       NMS / RS232 / 9600 bps / 8 bit data / Even parity /
                        1 stop bit
5 ) Handshaking         CTS Clear To Send / CD RSSI threshold / RTS Ignored /
                        Pause length 3 bytes
6 ) Additional Setup    SL-commands ON / LCD read-only OFF
7 ) Tests & Counters

A ) Restore factory settings
E ) EXIT and save settings
Q ) QUIT without saving

Enter selection >
```

Note: The default value RSSI threshold depends on the channel spacing as follows:
-112 dBm @ 25 kHz
-114 dBm @ 12.5 kHz

Note: Some settings may be market area dependent. For more details contact the authorized SATEL dealer in your market area or SATEL Technical Support (technical.support@satel.com).

Table 2.2. Serial ports 1&2 - available functions and interface levels		
Port	*Function*	*Interface level*
Port 1	DATA/NMS/OFF	RS-232
Port 2	NMS /DATA/OFF	RS-232/485/422
Only one DATA port and one NMS port are available; if the other port is selected as the DATA port, the function of the other port must be either NMS or OFF.		

Table 2.3. Possible DATA port and the NMS port configurations.				
Port	*Data speed*	*Characters*	*Parity*	*Stop bits*
DATA	1200…38400 bps	7 or 8 bit data	None, Even, Odd	1 or 2
NMS	9600 bps	8 bit data	Even	1

Table 2.4. SETTINGS of SATELLINE-3AS NMS / NMS Epic / NMS 869 / VHF

FIXED SETTINGS defined at the time of order (these settings can be changed only in SATEL manufacturing premises)		
Setting	*Value*	*Notes*
Frequency band(s) limits	Specified in the order form!	See table 2.1.
Channel spacing	Specified in the order form!	See table 2.1.
ADJUSTABLE SETTINGS (user can change these settings later on)		
Setting	*Default value*	*Notes*
Operating frequency	Centre of the Frequency band (Exception: 3AS NMS 869 is delivered with 869.4125 MHz).	Any frequency inside the Frequency band(s). The receiver and the transmitter frequencies can be defined individually.
TxPower	1 W (3AS NMS and VHF) 10 W (Epic) 0.5 W (NMS 869)	See Chapter 6.1
RSSI threshold	-112 dBm (12.5 kHz, 20 kHz) -114 dBm (25 kHz)	See Chapter 6.2
FEC	OFF	See Chapter 6.3
TxDelay	0 ms	See Chapter 6.7
SyncInterval	default (=21845 bytes)	See Chapter 6.8
RxDelay	0 ms	
Error check	OFF	See Chapter 6.4
Network mode	Basic Tx-priority	See Chapter 7
Serial port 1 settings	Port function=DATA Data speed=19200 bps Data bits=8 Parity=None Stop bits=1	See Chapter 5
Serial port 2 settings:	Port function=NMS Data speed= 9600 Data bits=8 Parity=Even Stop bits=1 Interface level=RS232	See Chapter 5
Handshaking settings	CTS=Clear to send RTS=Ignored CD=RSSI threshold Pause length=3 bytes	Handshaking lines apply to the DATA port. See Chapter 5.6
SL commands	OFF	See Chapter 13
LCD-read-only	OFF	See Chapter 10
Modem name	"Modem_Name"	User can give any descriptive name that will be shown on the LCD, *Programming menu* and Satel NMS PC.
NMS & NETWORK LEVEL SETTINGS (for example routing, topology of the system, terminal addresses, user protocols) are configured using SATEL NMS PC PROGRAM. The configuration can be performed by the customer, local SATEL representative (contacts on www.satel.com → Distributors) or SATEL Network Design Centre (ndc@satel.com) with all the necessary details concerning the system before ordering).		

3 NMS - NETWORK MANAGEMENT SYSTEM

The purpose of the NMS (Network Monitoring System) is to provide tools for management of a radio network built on SATELLINE-3AS NMS radio modems. NMS allows user to manage, monitor, diagnose and configure SATELLINE-3AS NMS modem network remotely without disturbing user's data flow.
This chapter includes a very short description of SATEL NMS for SATELLINE-3AS NMS radio modem family. More information is provided by the SATEL NMS PC user manual and application notes.

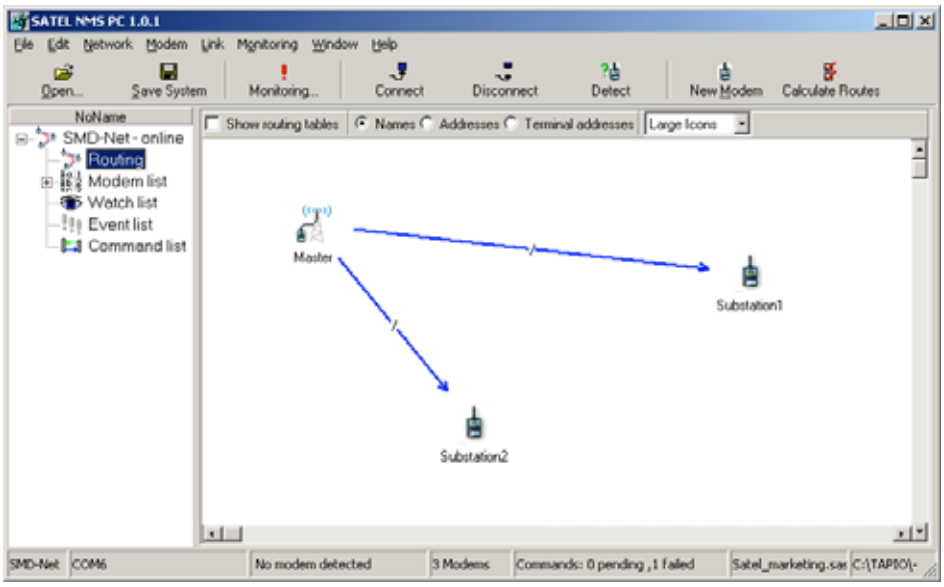


Figure 3.1. A typical screen shot of SATEL NMS PC software. (Routing view).

3.1 System components

SATEL NMS consists of:

- SATEL NMS PC program running on Microsoft Windows® operating system. The program provides the user interface showing the status of the network:
  - Graphical network overview
  - Sort able lists of all modems and radio links
  - Link quality tests and monitoring
  - Alarms generated on link failure, operating voltage drop etc.
  - Remote administration of modem parameters
  - Log files
- The diagnostic functions in the SATELLINE-3AS NMS radio modem software. The set of features depends on the hardware and software version of the radio modem.
  - One of the modems operates as the *Master modem* of the system (*Network Mode* parameter of the radio modem set to *Advanced - Master*).
  - The other modems are the *substations* of the network (*Network Mode* parameter of the substation radio modems set to *Advanced - Slave*).

3.2 NMS - Installation

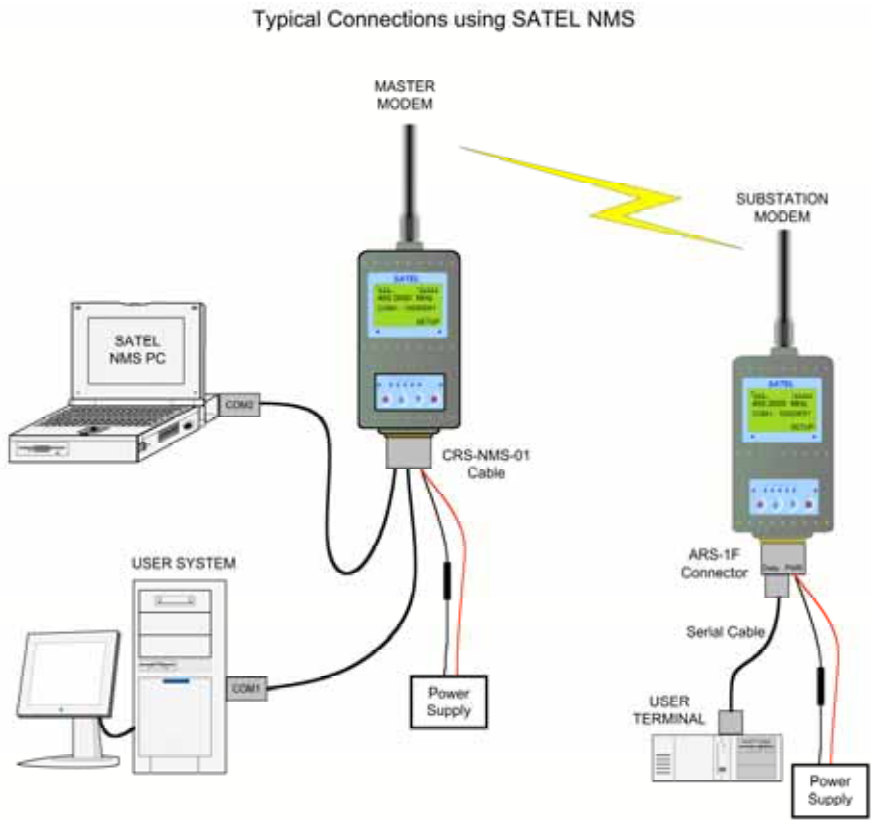


Figure 3.2. SATELLINE-3AS NMS equipment

SATELLINE-3AS NMS radio modem has two serial ports - *Port1* and *Port2*. One of the ports is configured as the DATA port (by default *Port1*) that is connected to the user application. The other port is the NMS port (by default *Port2*) that is connected to the serial port of the PC running SATEL NMS PC software. See the figure above.
The easiest way to accomplish the wiring is to use a two-port serial cable (e.g. part code CRS-NMS from SATEL). See the wiring schematic in sub clause 14.2.1.

3.3 NMS - Usage

SATEL NMS PC software provides the user interface to NMS system. Refer SATEL NMS PC User Guide for additional information.

3.4 NMS functionality

SATEL NMS provides useful tools for maintaining the radio network. The following functions are included in the SATEL NMS system:

- Status of the network can be obtained easily. Received Signal strength (RSSI) information, Voltage, Temperature and quality of the radio links can be monitored without disturbing user's data flow. SATEL NMS PC software collects statistics on the radio modems of the network.
- Alarms (triggered e.g. by a significant decrease in signal level of a radio link) are generated for the external system usage.
- The history of the parameters is saved to log files for later examination.
- Remote update of the setup i.e. the settings of a radio modem.
- Data communication tests. A full data communication test can be run to find out more detailed analysis of each radio link. Whenever needed this test indicate profoundly the quality of the radio communication.

NOTE: Remote update of the actual firmware of a radio modem is currently NOT supported by SATELLINE-3AS NMS.

SATEL NMS system is subject to continuous development - new features will be introduced to respond actual customer needs. The radio modems have a comprehensive interface structure that enables even more complex functions to be added to SATEL NMS PC while radio modem needs to manage only a limited set of tasks.
The customers who want to implement their own NMS interface to SATELLINE-3AS NMS radio modems should contact SATEL technical support (technical.support@satel.com).

3.5 Requirements for the user system

SATEL NMS fits the systems that are:

- Single master systems with point-to-multipoint network structure
- Based on polling protocol (the master polls the slaves regularly)
- Transferring user messages not larger than 1kByte

Other kinds of systems may also be possible but require careful consideration; in such cases the customer is advised to contact SATEL for more information.

Repeater stations are fully supported. While operating the monitoring system, radio data links are transparent. Because NMS data is invisible to the user's system, most user protocols are not interfered by NMS. However, note that on-line NMS always affect the real time operation of any system due to the extra information transferred. In some cases this means that the parameter defining the timeout of the slave station reply must be increased. Depending on how much NMS information is required, NMS introduces an extra load of ~20…60 bytes per a message.

3.6 Designing Systems and Networks

The Routing window of SATEL NMS PC software provides a graphical tool for designing the radio network. It is used by simply dragging and dropping modem icons on the sheet and linking the modems and finally uploading these settings to individual modems.

The designing of any radio modem system requires very precise planning. Once the choices between devices, their locations, installation, maintenance etc. are clear, the project file for the system can be implemented by using SATEL NMS PC software. Please refer to the SATEL NMS PC User Guide for more detailed description.

Please check also the chapter "2.6 Settings" before changing any settings of the radio modems. Configure the radio modems accordingly using SATEL NMS PC. Finally, when all the radio modems have correct settings, they are ready for further installation.

4 INTERFACE - CONNECTORS & LEDS

4.1 Antenna connector

TNC female 50 Ω connector.

The antenna should always be connected when the power is on. Removing the antenna while the transmitter is on may damage the power amplifier inside the transmitter.

4.2 LED indicators

There are five (5) LEDs indicating the status of the serial port (*DATA* port) and the radio interface on the front panel of the radio modem. See the table below for the description of operation.

Table 4.1. SATELLINE-3AS(d) NMS, NMS Epic, NMS 869, VHF LED INDICATORS

LED	*Indication*	*OFF*	*Red*	*Orange*	*Green*
RTS	RTS-line status (D15 Pin 13)	Inactive	Active	-	-
CTS	CTS-line status (D15 Pin 6)	Inactive	Active	-	-
TD	TD-line status (D15 Pin 11) *TD* indicates that the radio modem is receiving data via serial port.	No data	Data	-	Test Tx active
RD	RD-line status (D15 Pin 9) *RD* indicates that the radio modem is sending data via serial port.	No data	Data	-	-
CD	*CD* indicates the status of the radio interface.	No signal	Transmitter is ON	Noise	Reception
*Note**) The status of CD-line (D15 connector pin 2) may differ from the status of CD LED.					
LED ERROR CODES: In case the self-diagnostics routine of the radio modem detects a malfunction in the start up, ALL LEDs shine red for 1 second after which the error code is indicated.					

When the self-diagnostics function of the modem discovers an error, the modem will go to the ERROR-state. In the ERROR-state the data transmission and reception are disabled. Instead of data transfer, the LED indicators follow the sequence: All LEDs ON -> All LEDs OFF -> ERROR code -> All LEDs ON...

4.3 D15 connector

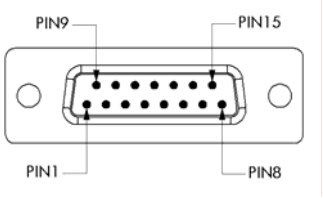


Table 4.2. NMS 15-PIN FEMALE D CONNECTOR PINOUT

- DTE is an abbreviation for Data Terminal Equipment
- I/O column below denotes the direction of the signal:
  "IN" is from DTE to the radio modem, "OUT" is from the radio modem to the DTE.

PIN	*NAME*	*I/O*	*LEVEL*	*EXPLANATION*
1	**DTR**	IN	0..30V	Data Terminal Ready. The pin can be used to wake-up the radio module from the standby mode. > +2 VDC = ON, Not connected = ON, < +0.6 VDC = STANDBY
2	Pin 2 has alternative functions depending on the *Port2* configuration, see below.			
	CD	OUT	RS-232	Carrier Detect (if *Port2* selection is RS-232)
	A'	OUT	RS-422	*Port2* Receive Data positive (if *Port2* selection is RS-422)
	A	IN/OUT	RS-485	*Port2* Data positive. *Note***) (if *Port2* selection is RS-485)
3	Pin 3 has alternative functions depending on the *Port2* configuration, see below.			
	RD2	OUT	RS-232	*Port2* Receive Data (if *Port2* selection is RS-232)
	B'	OUT	RS-422	*Port2* Receive Data negative (if *Port2* selection is RS-422)
	B	IN/OUT	RS-485	*Port2* Data negative. *Note***) (if *Port2* selection is RS-485)
4	Pin 4 has alternative functions depending on the configuration, see below.			
	TD2	IN	RS-232	*Port2* Transmit Data (if *Port2* selection is RS-232)
	A	IN	RS-422	*Port2* Transmit Data positive (if *Port2* selection is RS-422)
5	Pin 5 has alternative functions depending on the hardware assembly, see below.			
	B	IN	RS-422	*Port2* Transmit data negative (default hardware)
	RSSI	OUT	0..5V	Analogue RSSI (requires the special hardware assembly, needs to be defined in order sheet!)
6	**CTS**	OUT	RS-232	Clear To Send. This signal indicates that the radio modem serial interface is ready to receive data from DTE. *Note**)
7, 8	**GND**	-		Operating voltage and Signal Ground
9	**RD1**	OUT	RS-232	*Port1* Receive Data to DTE from the radio modem
10	**DSR**	OUT	RS-232	Data Set Ready. Indicates that the radio modem is ON.
11	**TD1**	IN	RS-232	*Port1* Transmit Data from DTE to the radio modem.
12	**MODE**	IN	0..30V	<2VDC or connected to ground = *Programming Mode* >3VDC or Not connected = *Data Transfer Mode* *Note****)
13	**RTS**	IN	RS-232	Request To Send from DTE. *Note**)
14, 15	**V_b**	-	See spec. sheets	Operating Voltage. +10.8...30 VDC for 3AS(d) NMS Epic +8...30 VDC for 3AS(d) NMS, NMS 869, VHF

Note! Unused pins can be left unconnected.
*Note**) RTS and CTS signals apply to the Data port-either *Port1* or *Port2* depending on the configuration.
*Note***) A and B designators are opposite in Profibus standard.
*Note****) *Programming Mode* is for changing the settings of the radio modem via *Programming menu*. Normally the MODE line is NOT connected i.e. the radio modem is in *Data Transfer Mode*.

5 SERIAL INTERFACE

The radio modem is referred to as DCE (Data Communication Equipment) whereas the PC is referred to as DTE (Data Terminal Equipment). The 15-pin female 'D'-type connector of the radio modem contains the connections required to establish data communication between the radio modem and DTE.

The radio modem contains two separate serial ports, which are designated *Port 1* and *Port 2.* One and only one of the ports at a time can operate as the DATA port for user data, while the other port can be used as the NMS port for the diagnostics interface to SATEL NMS PC software.
The user can select which one of the serial ports operates as the DATA port or NMS port by configuring the radio modem in the *Programming Mode* or by using the LCD interface.

The physical interface of the serial ports is as follows:
- *Port 1* complies always with the RS-232 standard.
- *Port 2* can comply either with the RS-232, RS-422 or RS-485 standards. The user can change the *Port 2* interface type in the *Programming Mode* or by using the LCD interface.

The handshaking signals apply to the selected DATA port. The handshaking signals are CD (Carrier Detect), RTS (Ready To Send), CTS (Clear To Send), DSR (Data Set Ready) and DTR (Data Terminal Ready). The physical level of these signals is always RS-232. See the chapter 5.6 *Handshake lines* for additional information.

NOTE!
WHEN THE MODE PIN (PIN 12 OF THE D-CONNECTOR) IS GROUNDED, THE RADIO MODEM IS IN THE PROGRAMMING MODE AND **Port 1** (PINS 7, 9, 11) IS IN ACTIVE USE!
If you normally use **Port 2** for data transmission, the serial cable must be changed to a standard (direct) serial cable when switching over to the configuration mode.

5.1 RS-232 interface

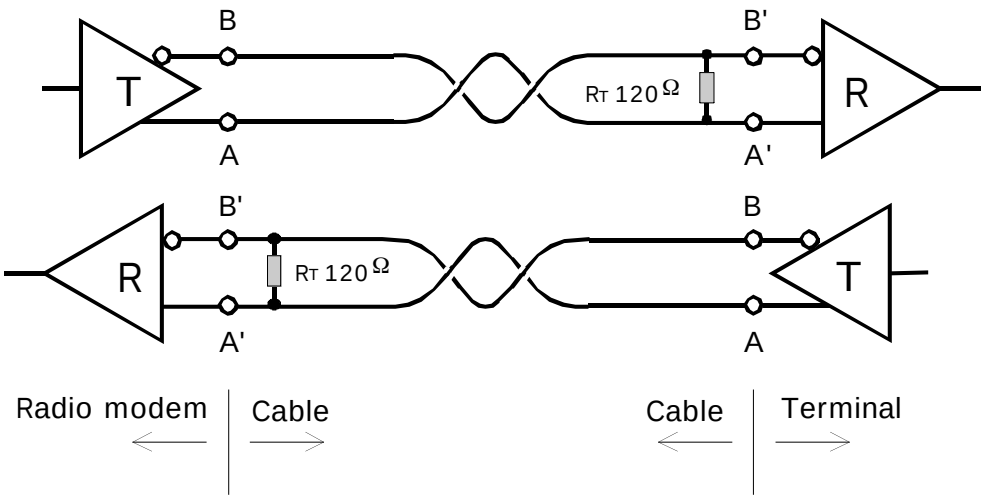
RS-232 standard defines the method of serial data transfer between a computer and its peripherals. The definition includes both the interface type and signal levels. Most computers and peripherals contain one or more RS-232 type serial ports. The RS-232 standard uses transmission lines, in which each single signal line level is referenced, to a common ground level. RS-232 has been designed to be use in serial transfer of data in situations where the distance between communicating equipment is less than 15 m. *The otherwise useful RS-232 standard is applied in a multitude of slightly differing ways, (e.g. different pin configurations) and for this reason different computers and peripherals are not necessarily directly compatible with each other (see also Chapter 14.2 for more information on RS-232 wiring).*

When connecting equipment using RS-232 interface make sure that the equipment are connected together sharing the same ground potential. Major differences in ground potentials may result to large current flow in the GND wire of the RS-232 interface and may lead to a malfunction or damage the connected devices!

5.2 RS-422 interface

RS-422 standard defines a serial data transfer method, which is very similar to the RS-232 standard. In RS-422 however, the signal lines are balanced (or differential) transmission lines. A balanced (or differential) transmission line is formed by using two signal wires together to convey each single signal. Because the state of the signal is defined by the mutual voltage difference (hence the name differential), any common mode interferences induced into the lines will cancel out. The effect of different signals moving in the same cable will also be smaller than in the case of the RS-232. Transmission distance can be considerably longer than when using RS-232 type of connection, and distances up to 1 km are possible. (See also Chapter 14.2 for more information on RS-422 wiring).

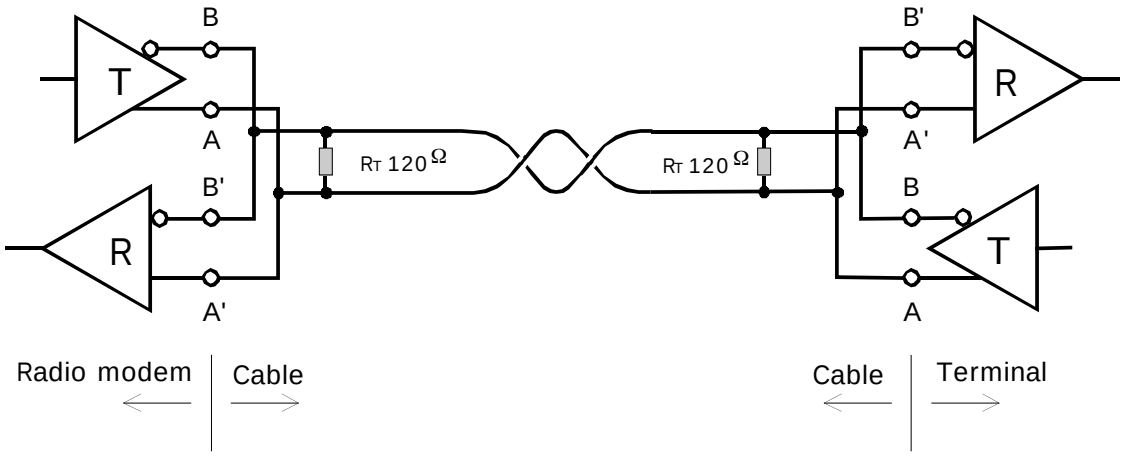
As an example, let's examine the TX-signal: TX-signal will be transmitted using two lines (A and B). A logical "1" corresponds to a situation, where the voltage on line A is greater than the voltage on line B. Correspondingly a logical "0" corresponds to a situation, where the voltage on line A is smaller than the voltage on line B.



Picture 5.1. RS-422 interface

5.3 RS-485 interface

RS-485 is an extension of the RS-422 standard and enables the connection of more than two devices on to the same bus. Communication is half-duplex, so there is only one cable pair, compared to two when using the RS-422. The RS-485 standard defines the electrical characteristics of the connections in such a way as to prevent possible data contention states as well as cable short circuits etc. from harming the devices themselves. (See also Chapter 14.2 for more information on RS-485 wiring).



Picture 5.2. RS-485 interface

5.4 Termination of RS-422/485 lines

Each differential pair of wires is a transmission line. A transmission line must be terminated properly to prevent, or at least minimise, harmful reflections formed between the transmitting and receiving end of the transmission line. A common method of terminating an RS-485 type of transmission line is to connect a so-called terminating resistor between the wires at both ends of the transmission line. Even when there are more than two devices on the same transmission line, the terminating resistors are needed only at transmission line ends. The terminating resistor must be selected so that its resistance matches to the characteristic impedance of the transmission line as close as possible. Typical value range is from 100 to 120Ω. When using an RS-422 type of connection the terminating resistor is connected only at both receiving end. Terminating resistors are particularly important, when long transmission lines and/or high data transfer speeds are used.

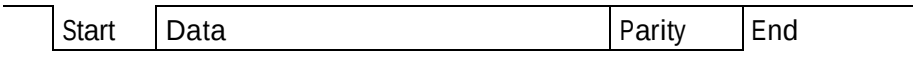
5.5 Serial interface, data format

The table below shows the available options for selected DATA port. The NMS port has fixed settings.

Table 5.1. Possible DATA port and the NMS port configurations.

Port	*Data speed*	*Characters*	*Parity*	*Stop bits*
DATA	1200 2400 4800 9600 19200 38400 bps	7 or 8 bit data	None, Even or Odd	1 or 2
NMS	9600 bps	8 bit data	Even	1
Note: 300 or 600 bps data speeds nor 9-bit data are not supported!				

The serial interface uses an asynchronous data format. One character to be transmitted contains a start bit, the data bits (defining the specific character in question), an optional parity bit and one or two stop bits. Therefore the overall length of one character is 10 or 11 bits. This should be taken into account when calculating the data throughput capability of a system. A useful rule of thumb is that the transmission of one character will require roughly one millisecond (1 ms) with data transfer speed of 9600 bps.



Picture 5.3. Asynchronous character data format on the serial line

Example: With an 8-bit data character length and taking, for example, a decimal value of ”204”, (corresponding to a binary value of ”11001100”) and with a start bit value of ”0”, parity bit set to either “NO” (NONE), ”0” or ”1” and with a stop bit value of ”1”, the possible combinations are listed in the table below:

DATA FORMAT	CHARACTER (binary value)	CHARACTER LENGTH (total)
8 bit, no parity, 1 stop bit	0110011001	10 bit
8 bit, even parity, 1 stop bit	01100110001	11 bit
8 bit, odd parity, 1 stop bit	01100110011	11 bit
8 bit, no parity, 2 stop bits	01100110011	11 bit
8 bit, even parity, 2 stop bits	011001100011	12 bit
8 bit, odd parity, 2 stop bits	011001100111	12 bit

The radio modem serial port settings and the terminal device connected to it must have equal data port settings (data speed, character length, parity and the number of stop bits.
The serial port settings can be changed in the *Programming Mode* or via LCD display.

5.6 Handshaking lines

When using the RS-232 serial interface, handshaking signals can be used to control data transfer on the DATA port. For example, the radio modem can inform the DTE that the radio channel is busy, and that it is not allowed to initiate transmission.

A common way of using handshaking signals is to monitor the CTS line and ignore the others. Usually the terminal device is fast enough to handle the data received by the radio modem, so the use of RTS line is not necessary.

Handshaking is not needed if the system protocol is designed to prevent collisions (data contentions) by using poll queries, or if there is only little traffic and, if there is no harm from occasional data contention situations (two or more radio modems trying to transmit at the same time).

5.6.1 CTS line

CTS (Clear To Send) is a signal from the radio modem to the DTE. It indicates when the radio modem is ready to accept more data from the DTE. The options for CTS line controls are:

1) **Clear To Send**
CTS line is set active when the radio modem is ready to accept data for transmission. CTS will shift into inactive state during data reception, and when a pause (packet end) is detected in transmitted data. CTS shifts back into active state either when reception ends or the radio modem has finished data transmission. CTS will also shift into inactive state when the serial interface data transfer speed is greater than the radio interface transfer speed, and the transmit buffer is in danger of overflowing.

2) **TX buffer state**
CTS line will shift into inactive state only when the data buffer for the data to be transmitted is in danger of overflowing.

5.6.2 CD line

CD (Carrier Detect) is a signal from the radio modem to the DTE. It indicates when there is activity on the radio channel. The options for CD line controls are:

1) **RSSI-threshold**
CD is active whenever a signal exceeding the defined threshold level required for reception, exists on the radio channel. It doesn't make any difference, whether the signal is actual data transmission, a signal of a radio transmitter not belonging into the system or even interference caused e.g. by a computer or some other peripheral device. CD is also active, when the radio modem itself is transmitting.

2) **Data on channel**
CD will switch to active state only after recognizing a valid data transmission from another SATELLINE-3AS NMS family radio modem. CD will not react to interferences like noise or possible other signals.

3) **Always ON**
CD is always in the active state. This option is usually used with terminal equipment using the CD line as an indicator of an active connection. In this case the radio modem can transmit and receive data at any time.

5.6.3 RTS line

RTS (Ready To Send) is a signal from the DTE to the radio modem. DTE controls the data flow from the radio modem by using RTS. The options for RTS line controls are:

1) **Ignored**
RTS line status is ignored.

2) **Flow control**
The radio modem transmits data to the terminal device only when the RTS line is active. Inactive state of the RTS line will force the radio modem to buffer the received data. This option is used, when the terminal device is too slow to handle data received from the radio modem.

3) **Reception control**
RTS line controls the reception process of the radio modem. An active RTS line enables reception. Inactive RTS line will interrupt reception process immediately, even if the radio modem is in the middle of receiving a data packet. This option is used to force the radio modem into WAIT State for an immediate channel change.

5.6.4 DTR line

DTR (Data Terminal Ready) is a signal from the DTE to the radio modem. DTR has a special function in the radio modem - it can be used as an external ON/OFF switch for power saving purposes.

The radio modem is:

- ON, if the voltage at the DTR pin is more than +2 VDC.
- OFF, in the Stand-by Mode if the voltage at the DTR pin is less than +0.6 VDC.

Note: If the DTR pin is not connected, the radio modem is ON.

5.6.5 DSR line

DSR (Data Set Ready) is a signal from the radio modem to the DTE. It indicates that the radio modem is powered up. DSR is typically ignored.

5.7 Pause length

The radio modem recognizes a pause on the serial line (a pause is defined as a time with no status changes in the TD line). The pause detection is used as criteria for:
- End of radio transmission - When the transmit buffer is empty and a pause is detected, the modem stops the transmission and will change the radio to the receiving mode
- SL command recognition - For an SL command to be valid, a pause must be detected before the actual "SL" prefix of the SL command.
- User address recognition
In order for detecting the message, a pause must precede it in transmission.

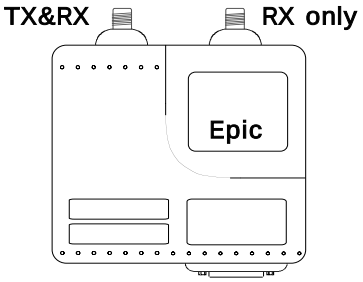
Traditionally, in asynchronous data communication, pauses have been used to separate serial messages from each other. However the use of non-real-time operating systems (frequently used on PC type hardware) has changed this tradition by adding random pauses in the asynchronous data stream. Such systems can't serve the hardware UART properly when performing other tasks (other applications or tasks of the operating system itself).
The pauses described above are typically up to 100 ms. When such a pause appears in the middle of a user message, the radio modem transmits the message as two separate radio transmissions. This will generate problems in at least two ways:
1) The inter-character delay will be increased by at least the time of the modem transfer delay
2) The probability of collisions on the radio path will increase. This will be especially harmful for repeater chains

The default value for the Pause length is 3 bytes.

6 RF INTERFACE

SATELLINE-3AS(d) NMS / NMS Epic / NMS 869 / VHF have a single TNC type connector with impedance of 50 Ω.

SATELLINE-3AS(d) NMS Epic has two antenna connectors, the one on the left for both transmitting and receiving and the other on the right for receiving only (the diversity reception); see the picture on the right.
The diversity reception i.e. the secondary receiver of the Epic can be switched off (in single antenna applications) by changing the setting *Diversity Mode* OFF in the configuration. It is recommended to protect the unused antenna port by placing a suitable cap on the TNC connector.



Picture 6.1. 3AS(d) NMS Epic

When ordering the radio modem, the frequency band (or the center frequency) to which the radio modem will be tuned to must be defined. The user can change the radio modem operating frequency afterwards by ±1 MHz from the preset centre frequency (basic tuning range), or inside 2 X 2 MHz frequency bands, when using the special Dual Band variant assembly. SATELLINE-3AS VHF allows the user to change the operating frequency within whole radio board limits (138 … 160 MHz or 155 … 174 MHz).
All local regulations set forth by the authorities must be taken into account. The 3AS NMS 869 uses ten 25 kHz channels in European licence free 869 MHz frequency band.

The radio channel spacing is set at the factory and cannot be changed afterwards by modifying system settings. The data speed of the radio interface depends on the radio channel spacing as follows:

- 25 kHz channel -> 19200 bps
- 12.5/20 kHz channel -> 9600 bps

The data speed of the radio interface depends only on the channel spacing - it is irrespective of the data speed of the serial interface. If the data speeds of the radio interface and the serial interface differ from each other, the radio modem will buffer the data, when necessary, so no data loss will occur.

NOTE!
Adjusting the active radio channel to another frequency than allocated and/or allowed by local authorities, is strictly forbidden.
Use or intended use of forbidden frequencies may lead to prosecution and penalties.
SATEL Oy is not responsible for any illegal use practiced with any devices manufactured and/or sold by SATEL Oy and is not liable to pay any damages or compensation caused by such illegal use.

6.1 Transmitter

The output power of the transmitter is adjustable (see the table below for available values). The greatest allowable power depends on limits set by local authorities, which should not be exceeded under any circumstances. The output power of the transmitter should be set to the smallest possible level that still ensures error free connection under variable conditions. High output power levels used in short link spans can, in the worst case, cause interferences and affect to the overall operation of the system.

Table 6.1. **The transmitter output power levels of the SATELLINE-3AS(d) NMS family radio modems.**

OUTPUT POWER	dBm	3AS NMS	NMS 869	NMS Epic	VHF
10 mW	+10	•	•		
20 mW	+13	•	•		
50 mW	+17	•	•		
100 mW	+20	•	•		•
200 mW	+23	•	•		
500 mW	+27	•	•		•
1 W	+30	•		•	•
2 W	+33			•	
5 W	+37			•	•
10 W	+40			•	

NOTE!
Setting the radio data modem output power level to exceed the regulations set forth by local authorities is strictly forbidden. The setting and/or using of non-approved power level may lead to prosecution. SATEL Oy and its distributors are not responsible for any illegal use of its radio equipment, and are not responsible in any way of any claims or penalties arising from the operation of its radio equipment in ways contradictory to local regulations and/or requirements and/or laws.

NOTE!
Additional cooling is required in case the transmitter of SATELLINE-3AS(d) NMS Epic radio modem has over 20 % duty cycle at the full power (or the constant transmitter on-time exceeds 2 minutes at the full power). The product variant SATELLINE-3AS(d) NMS Epic C includes the necessary cooling element.

NOTE!
Additional cooling is required in case the output power of SATELLINE-3AS(d) VHF radio modem is 5 W. The product variant SATELLINE-3AS(d) VHF C includes the necessary cooling element.

6.2 Receiver

The sensitivity of the receiver depends on the channel spacing of the radio modem (=data speed of the radio interface) and on the mode of the FEC (Forward Error Correction) according to the table below:

Table 6.2. **Effect of settings on the receiver sensitivity**		
Channel spacing	*Sensitivity FEC OFF*	*Sensitivity FEC ON*
25 kHz	-110 dBm	-113 dBm
12,5 kHz	-112 dBm	-115 dBm

SATELLINE-3AS(d) NMS Epic radio modem contains two separate receivers, which are used simultaneously. The selection between received signals is made in order that the stronger/better signal is used. By using this method, the signal fading caused by multipath propagation will be smaller than in case, where just one antenna and receiver is used. The recommended minimum distance between two receiving antennas is ¾ wavelengths, app. 50 cm at 450 MHz frequency range.

6.2.1 RSSI and RSSI threshold level

The radio modem measures constantly the received signal strength of the receiver. The RSSI Threshold Level of the receiver is the important parameter determining the level, above which the search for the messages from the radio receiver transfer signal is active. It is recommended that values given in the table 6.2 are used as a basis. If the Signal Threshold Level setting is set too low (the CD LED is ON constantly), it is possible that the receiver is trying to synchronise itself with noise. In such case the actual data transmission might remain unnoticed. If the RSSI threshold is set too high, the weak data transmissions will be rejected although they could be otherwise acceptable.

The RSSI threshold should only be changed for a reason. For example in the following cases:

- Continuous interference is present and the desired signal is strong. In this case the RSSI threshold can be increased to prevent the modem from synchronising to the interfering signal(s) and /or possible noise.
- Maximum sensitivity should be achieved and the desired signal is very weak. In this case the sensitivity could increase by decreasing the RSSI threshold. This type of situation is usually a sign of a poorly constructed radio network / contact. Bit errors and momentary loss of signals can be expected in this kind of a situation. Some data might be successfully transferred.

The radio modems equipped with an LCD display show the RSSI of the last received message in dBm units. The RSSI can be requested also locally by using a special SL command (SL@R?). The RSSI value is available 7s after the receiving the message. After that the value is returned to zero. SATELLINE-3AS NMS Epic responds by the stronger RSSI value of the two receivers.

SATELLINE-3AS NMS / NMS Epic / NMS 869 / VHF radio modems do not include an analogue RSSI signal - it is a special hardware assembly option that must be specified in the order.

6.3 Error correction

SATELLINE-3AS(d) NMS has the error correction feature called the FEC method (**F**orward **E**rror **C**orrection). When FEC is enabled (ON), the radio modem automatically adds additional error correction information, which increases the amount of transmitted data by 30 %. It is used by the receiving radio modem to correct erroneous bits - as long as the ratio of correct and erroneous bits is reasonable. FEC improves the reliability of data transfer via the radio interface especially in unfavourable conditions. FEC function should be used when link distances are long and/or if there are lot of interferences in the radio channels used. Using the FEC function will decreases the data transfer throughput by app. 30 %. See Appendix B for the exact transfer delays introduced by using FEC function.

NOTE!
All radio modems that are to communicate with each other must have the same setting for FEC (ON or OFF). If the transmitting radio modem and the receiving radio modem has different settings, data will not be received correctly.

6.4 Error checking

The purpose of the error checking is to detect possible errors happened in the data transfer. The radio modem transfers user data over the radio link by fitting it to sub-frames and adds checksums to the transmitted data. In case the error checking is switched on, the receiving modem calculates the checksums and verifies the received data before it forwards the data to the serial port. SATELLINE-3AS NMS supports three different methods of error checking in order to verify that the received data is proper:

No Error Check

In this mode the received data is NOT verified at all. This is the fastest mode because received data is given out to the terminal device immediately after it has been received. This is the default mode and it is recommended in case the user protocol includes the error checking feature of its own.

Partial Error Check

This mode means that the radio modem checks the received data in small data blocks and sends the validated sub-messages to DTE. Once an error is detected, the rest of the message is ignored. That is, if an error takes place in the middle of a message then the first part of the message is forwarded to the terminal device, but the data inside the erroneous sub-frame and the rest of the data will be ignored.

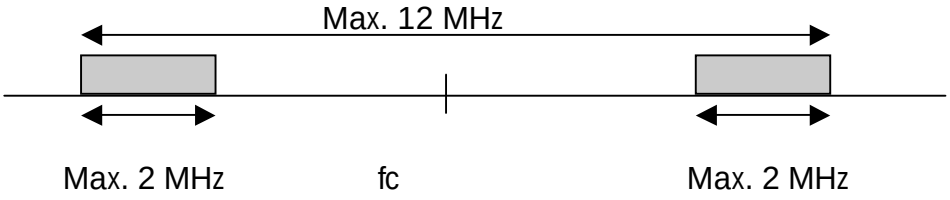
Full Error Check

In this mode the radio modem waits until the end of the reception and checks the whole received message before forwarding it to DTE. The additional time delay compared to No Error Check is roughly the time needed to transfer the user data message over the serial line.

6.5 Dual band version

SATELLINE-3AS(d) NMS radio modem is also available as a special "Dual Band" version. The radio transceiver of the Dual Band version offers two times two MHz frequency bands, and radio modem can be reconfigured to operate at any channel within those two bands. The frequency bands are tuned at SATEL manufacturing premises. The maximum separation between the highest and the lowest frequency can be 12 MHz.

The centre frequency (fc) is set to the middle of the two frequency bands. When using the SL commands, please note that SL&F=nnn.nnnn is the only command for frequency change which works in all cases. (SL&+/-=nn command can be used only when the required value for nn does not exceed 99.)

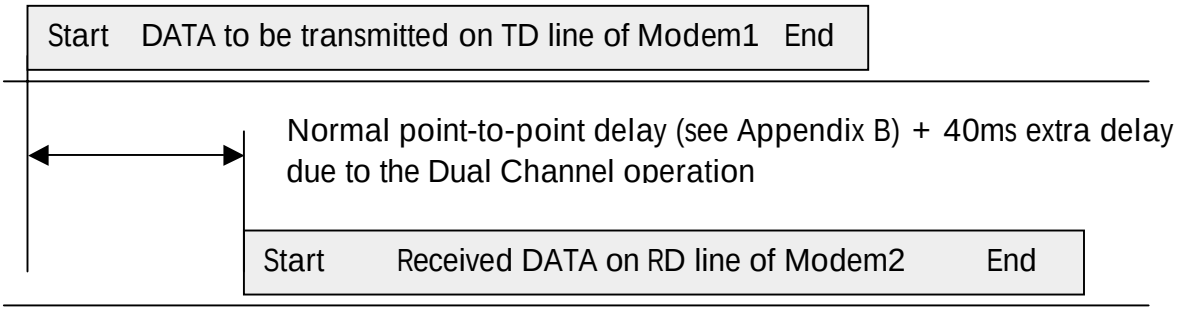


Picture 6.2. Dual band scheme

NOTE!
SATELLINE-3AS(d) NMS Dual Band is a special hardware version, and the frequency adjustment is done case by case. Before starting the system design procedure, please contact the manufacturer for checking the technical details.

6.6 Dual channel operation

By setting the Rx and Tx frequencies different to each other the radio modem transmits and receives data on separate radio channels (although not simultaneously). The radio modem is initially on the receiving channel. Data flow on the TD line starts the transmitter automatically and the frequency is changed to the transmitting channel. The delay caused by the frequency change - before the actual data can be transmitted - is 40 ms, and the same time is needed for returning to the receiving channel after completing the transmission. The extra delay from a modem to another is shown below:


Start DATA to be transmitted on TD line of Modem1 End
Normal point-to-point delay (see Appendix B) + 40ms extra delay due to the Dual Channel operation
Start Received DATA on RD line of Modem2 End

Picture 6.3. Dual channel scheme

6.7 TX Delay

The radio modem can be configured to delay the beginning of a radio transmission by 1...65000 ms. This feature is for preventing packet contention in a system where all substations would otherwise answer a poll query of a base station simultaneously. During this delay data sent to the radio modem is buffered. If this function is not needed, the delay time should be kept as 0 ms (default value).

6.8 Sync Interval

Normally the length of a single radio transmission is not limited by the radio modem. The transmission ends when:

- The buffer of the transmitter is empty and a pause has been detected on the serial data coming from the DTE (the default value of the Pause length parameter is 3 bytes (~1.5 ms at 19200 bps, ~3 ms at 9600 bps)
- Or the buffer overflows.

In some applications, especially in the remote control systems, the transmission can be of infinite length. The radio modem transmits the synchronisation sequence and the radio message identifiers (the type of the message, addresses etc.) only in the beginning of each radio transmission. These signals might seem redundant to the user, but they are necessary for the receiver to be able to receive the transmitted message. Thus, if the receiver momentarily looses the reception of the transmitted message, it will not be able to synchronise back to the same message again. The receiver will stop reception and starts looking for the beginning of the next radio transmission, which in theory then might never come.

To overcome this problem the radio modem has the Sync Interval setting that limits the size of a radio frames. When the limit is reached the modem completes the current radio frame properly and starts the transmission of a new synchronisation sequence and the radio frame.
The drawback of this function is that the use of additional synchronisation sequences adds delays among the data transmission i.e. approximately 20ms delay will be introduced in the data flow (depending on the data speed at the serial port) each time an extra synchronisation sequence is transmitted. The optimum value of *Sync Interval* setting must be derived by experimental testing depending on the application.

7 NETWORK PROTOCOL MODES

SATELLINE-3AS NMS can operate in one of the following network protocol modes, which determine the way the radio modem handles and buffers data:

- Basic - RX Priority (transmit after receive)
- Basic - TX Priority (transmit immediately)
- Basic - Repeater (store & forward all)
- Advanced - Master (routing supported)
- Advanced - Slave (routing supported)

NMS, network addresses or routing is supported ONLY in the *Advanced Master* and *Advanced Slave Protocol modes*. Any radio modem in *Advanced Master or Advanced Slave* mode acts also as a repeater station automatically depending on the message.
The three *Basic* modes require that the user equipment perform the above-mentioned functions.

The radio modems in the Advanced Protocol modes ignore the messages sent by the radio modems in the Basic Protocol modes and vice versa.

7.1 Basic - RX Priority

SATELLINE-3AS NMS works as a plain transparent radio modem in the *Basic - RX Priority* mode i.e. it does NOT support routing or NMS features.
RX Priority here means that a radio modem tries to receive all data currently in the air. If a terminal device outputs data to be transmitted it will be buffered. The radio modem will wait until the reception has stopped before transmitting the buffered data. This will result in timing slacks to the system, but decreases the number of collisions on the air, which is particularly useful in systems based on multiple random accesses.

Note: In case the terminal device enters an SL command, any radio reception will be terminated and the SL command will be handled immediately.
Note: The diagnostic functions are disabled in the *Basic - RX Priority* mode.

7.2 Basic - TX Priority

Basic-TX priority mode means that a terminal device attached to a radio modem determines the timing of the transmission precisely. The transmitter is switched on immediately when the terminal device is starting to output data.
If the radio modem is already receiving data from the radio interface and data to be transmitted is detected on the TD line, the radio modem will stop the reception and switch to the transmit state. Thus there is no need to use RTS line to control the timing of transmission/reception.

Because the transmission has higher priority than reception normally in industrial systems, the default value of the *Protocol mode* is *Basic - TX Priority ON* which fits to most systems directly.

Note: The diagnostic functions are disabled in the *Basic-TX Priority* mode.

7.3 Basic - Repeater

SATELLINE-3AS NMS operates in a store and forward fashion in the *Basic - Repeater* mode. This means that the radio modem acts as a repeater station i.e. it first receives a message from the radio interface, buffers the received data (the maximum size of a message is 1 kB) and after the reception it transmits the buffered data to another radio modem. Only correctly received, valid messages are forwarded.

Note: *BASIC - REPEATER* MODE WORKS ONLY IN ONE REPEATER SYSTEMS!
If there are two or more repeater stations on the same radio frequency, a message will be bouncing between the repeater stations forever in an infinite loop. Instead, addressing must be used in systems that include more than one repeater, in order to prevent such situation and ensure that a message finally reaches the intended radio modem. The *Advanced - Master* and *Advanced - Slave* modes must be used in those cases - see the next two chapters.

In case a radio modem is in the range of both - original transmitter and the repeater - units, it will receive a message twice. In other words the duplicate messages appear on the serial interface. Terminal equipment can be also connected to the serial port of the repeater station. If the radio modem is already receiving a message to be forwarded, the data coming simultaneously from the serial port will be buffered until the store-and-forward procedure has been completed.
The store-and-forward procedure will be completed before transmitting any data - even in the case that the radio modem has received new data from the radio, while TX Delay is already activated and it expires in the middle of the store-and-forward procedure. The use of TX delay together with the Basic - Repeater mode should be avoided without a special reason.

Note: The diagnostic functions are disabled in the *Basic-TX Priority* mode.

7.4 Advanced Network Protocol modes

NMS, network addresses, use of multiple repeaters or NMS routing are supported ONLY in the *Advanced Master* and *Advanced Slave* Protocol modes.

The whole configuration is performed by using SATEL NMS PC program that creates the NMS routing information for the master modem based on the specific project design file. It also initializes and controls the NMS (Network Management System) of the radio network.

All network related settings i.e. SATEL NMS, addresses, identifiers or NMS routing are hidden (except the *Protocol mode* for the informative reason) from the LCD and the *Programming menu* due to their usability limitations for the purpose. Instead, SATEL NMS PC provides the user friendly interface to access all the settings.

Read through the chapter *SYSTEM DESIGN* to get the idea how to use the radio modem in the system.

7.4.1 Advanced - Master

The *Advanced - Master* mode must be used for the master modem of the user system. The master modem retains the routing information of the radio modem network and provides the gateway for SATEL NMS PC program to the network.

7.4.2 Advanced - Slave

In case NMS (Network Management System), addressed repeater stations or the routing features are required, the *Advanced - Slave* mode must be used for all - except for the master modem - modems of the network.
Any radio modem in *Advanced - Slave* mode works also as a repeater station automatically depending on the received radio message.

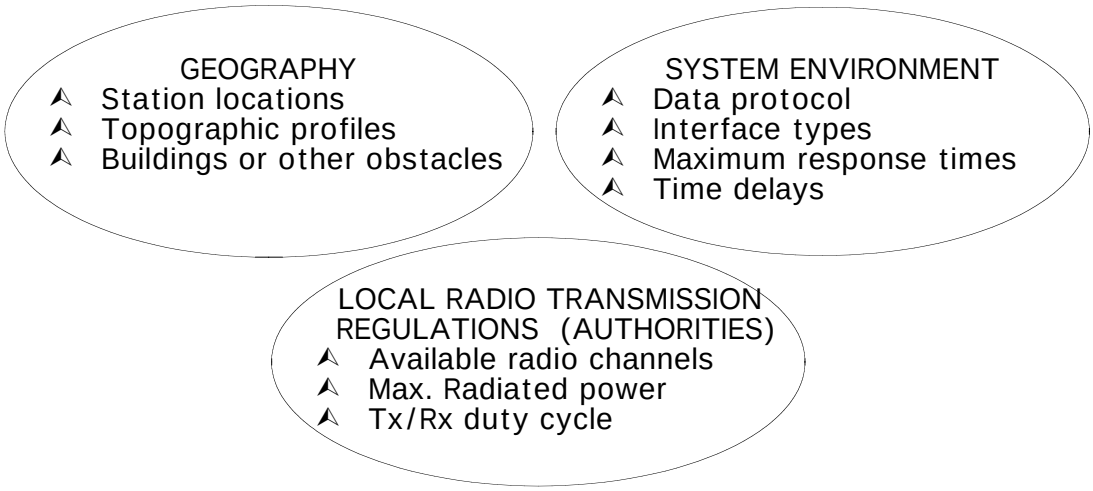
8 SYSTEM DESIGN

8.1 General

A. PLANNING NETWORK REQUIREMENTS

Like other engineering tasks, designing a radio modem network requires a set of rules to be followed for producing the desired result. Both the radio connections themselves and the compatibility of the surrounding system need to be considered.

The very first part of the designing is to evaluate the system environment requirements, geography and the local radio frequency and transmission laws and regulations.



B. PLANNING NETWORK HARDWARE

With the desired system performance and the limitations above in mind, the first version of the radio modem network can be designed:

1. Radio modem types and serial cable wirings are specified.
2. Radio links are simulated by giving the antenna types and heights, feeder cable lengths, and possible need of any additional repeater stations.
3. If necessary, other system components like RF filters, RF relays, combiners, lightning protectors, power supplies and mechanical installation parts are specified.
4. Data transmission delays are calculated for the sufficient number of RF channels.

After these four steps, the system design is typically detailed enough for a commercial quotation.

C. TESTING THE COMPONENTS BEFORE FINAL INSTALLATION

Data communication tests at the factory, radio signal propagation and radio interference tests on the field are important. The tests verify the functionality of the designed system, its compatibility to the surrounding system and the correct settings of the devices. Proper signal-to-interference margin (app. 15 – 20 dB) is essential for reliable error-free radio communication.

D. REPEATING THE TESTS AFTER FINAL INSTALLATION

By repeating the communication tests after the final installation the system designer may verify that the radio network design works properly with the desired application.

NETWORK DESIGN CENTER

In case you are not familiar in using wireless radio data modems or your system is complicated and you are not sure how to design the network, please feel free to contact SATEL representative for assistance. The fastest way of getting support is to contact the local SATEL distributor. However, if they do not have the resources or application specific know-how, the experts at SATEL Network Design Centre (ndc@satel.com) are prepared to assist. The service could include for example:

- A budgetary price to start with so you can estimate the overall expenses for your project. This would be based on your description of the system.
- Propagation measurements on site to ensure that the system will work properly
- Actual designing of the network based on the measurements
- Binding offer for the entire radio network including the radios, antennas, antenna feeder cables, data interface cables, connectors needed etc.
- Delivery of the high quality products in a short time due to our own production
- Installation of the radio network as an option together with our local distributor
- Testing of the system after installation including training of your staff
- Handing over of the network to you
- Guarantee

8.2 Configuration

Once the choices between devices, their location, installation, maintenance etc. are clear, the design and the configuration of the SATELLINE-3AS NMS / NMS Epic / NMS 869 / VHF radio modem system can be implemented in two ways depending on the desired configuration as described below.

SATEL NMS PC program provides the access to all user settings. SATEL NMS PC is also required in order to use the NMS or configure the routing scheme for the system. The procedure involves the followings steps:

1. Create a project file for a new system and fill in the common settings of the system (radio frequency, Network IDentifier, FEC and user protocol)
2. Draw a layout of the radio modem network using the graphical routing window.
3. Fill in settings such as addresses of the terminal equipment.
4. Connect and Transmit settings to the modems. When all the radio modems have correct settings, they are ready for further installation.
5. Test the network.
6. Start using and monitoring of the system.

See the user instructions of SATEL NMS PC program for the details of the configuration. Check also the chapter *2.6 Settings* of this user manual.

If the radio modem is to be used WITHOUT NMS OR NMS ROUTING in one of the *Basic Network modes*, then SATERM LITE or almost any common terminal program via the *Programming menu* can be used as a configuration tool. The *Programming menu* provides the access to very basic settings which are adequate for the systems where external logic takes care of the network level operation and has a total control over the data transfer of the radio network. The role of the radio modem is then to provide a plain transparent radio connection. All the messages are received by any other radio modem using the same settings.
See also the chapters *2.6 Settings* and *11.1 Programming Mode*.

8.3 System characteristics

The data transfer characteristics of SATELLINE-3AS NMS / NMS Epic / NMS 869 / VHF are designed to fit in real time systems. The full functionality of NMS is obtained in the user systems that have a single master polling scheme, where the master station polls every slave station regularly.

8.3.1 Features

- Transparent to user protocols.
- Easy construction of a network containing several repeaters.
- Any radio modem may operate as a repeater, i.e. dedicated repeaters are not usually needed thus cutting down on costs.
- Large coverage areas may be implemented by using only one radio channel.
- The system will be fully deterministic i.e. the transmission delays are predictable. Because of this, the principle of *NMS Routing* is connectionless.
- Added redundancy by using NMS, as a failing radio modem can be by-passed with another radio modem positioned in the same coverage area.

8.3.2 System requirements

- NMS and the internal routing features are intended mainly for the protocols based on polling scheme and a single master station. Other kinds of are possible but require careful planning - contact SATEL in uncertain cases.
- The maximum size of a single message is 1kB (kilobyte), if repeater stations are used.
- It is assumed that the position of the address field in the user messages is fixed (some special protocols can be supported though, and list will be growing).
- It is assumed that there is only one message at a time inside the network. Simultaneous messages could cause collisions.
- The maximum number of the routes depends on the actual hardware and the software version. Currently the maximum number of routes is 100.

8.3.3 Protocol support

Using the internal *Packet filter* feature the radio modem catches and transfers only the wanted messages/protocols - NMS also enables easy addition of higher level functions, like alternative routes and alarms in future development. The list of preset protocols includes for example:

- User defined
- Modbus ASCII
- Modbus RTU
- Rockwell DT1
- IEC60870-5-101
- DNP 3.0
- ANSI
- SATELLINK

8.3.4 Network ID

The Network ID is a character string which is used to prevent the reception of the messages coming from any external system. It applies only in the *Advanced Protocol modes*. The radio modems operating in the same system using *NMS Routing* must have the same Network ID. Only the messages that have a matching Network ID are received. Network ID is configured by using SATEL NMS PC.

8.4 Repeater stations

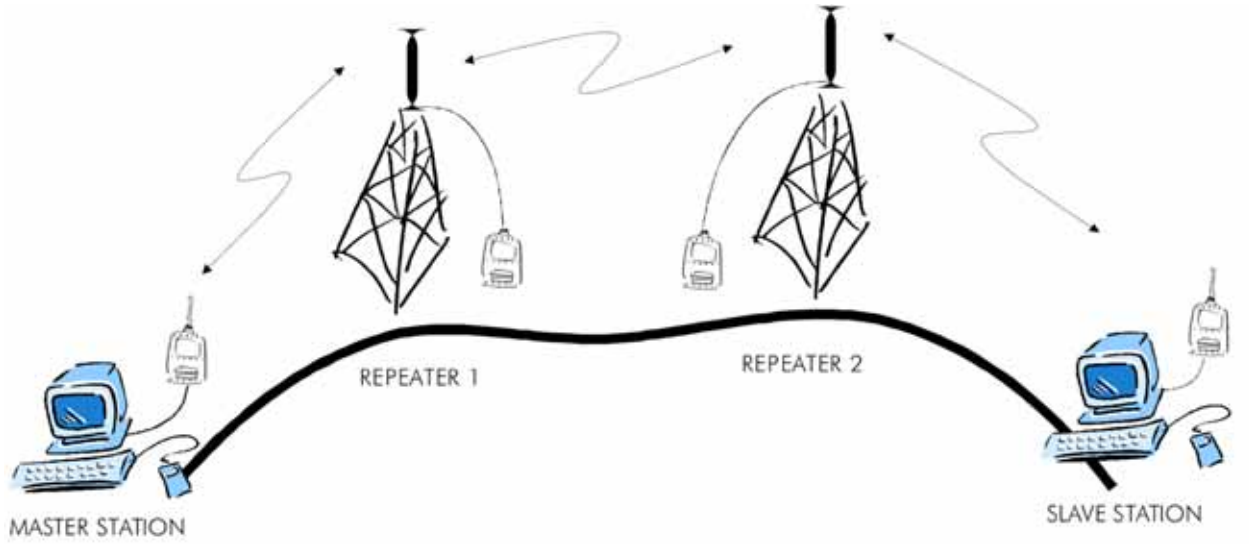
In circumstances where it is necessary to extend the coverage area of a radio modem network, SATELLINE-3AS(d) NMS / NMS Epic / NMS 869 / VHF radio modems can be used as repeater stations. The same network may include several repeaters, which operate under the same base station. Repeaters may also be chained; in which case a message is transmitted through several repeaters. In systems with more than one serial or parallel-chained repeater, addressing or routing protocol must be used to prevent a message ending up in an infinite loop formed by repeaters, and to ensure that the message finally reaches only the intended radio modem.

The maximum size of a repeated data packet is 1kB (kilobyte).

A radio modem acting as a repeater can be also connected to the serial interface:

- The radio modem in the *Basic-Repeater Protocol mode* will transmit all the received messages to the serial interface.
- The radio modem in the *Advanced-Master* or *Advanced-Slave* mode will transmit only the received messages addressed to its serial interface dictated by the route information in the message and the settings of the radio modem.
- The radio modem will transmit the data coming from the serial interface in a normal format in all *Protocol modes*.

The radio modems in the *Advanced Protocol modes* ignore the messages sent by the radio modems in the *Basic Protocol modes* and vice versa.



Picture 8.1. Repeater stations extend the coverage of the radio network. The end-to-end latency increases correspondingly.

8.5 Timing and delays during data transmission

When using a radio modem for data transmission, the use of a radio interface and the radio modem circuitry itself introduces start-up and data transfer delays. These delays exist when the radio modem switches from *Standby Mode* to *Data Transfer Mode* and during reception and transmission of data. See Appendix B for values in each case.

8.6 Data buffering in the radio data modem

A synchronisation signal is transmitted at the beginning of each radio transmission and this signal is detected by another radio modem, which then turns into receive mode. During the transmission of the synchronisation signal the radio modem buffers the data to be transmitted into its memory. Transmission ends when a pause is detected in the data flow sent by the terminal device, and after all the buffered data has been transmitted. When the data speed of the serial port is the same or slower than the speed of the radio interface, the internal transmit buffer memory can not overflow. However, when the serial interface speed exceeds the speed of the radio interface, data will eventually fill the transmit buffer memory. After the terminal device has stopped data transmission, it will take a moment for the radio modem to get the buffered data transmitted and get the transmitter switched off. The maximum size of transmit buffer memory is one kilobyte (1 kB). If the terminal device does not follow the status of the CTS line

and transmits too much data to the radio modem, the buffer will be cleared and the transmission is restarted.

In the receiving mode, the data coming from the radio is also buffered thus evening out differences in data transfer speeds at the serial ports.
If the terminal device transmits data to a radio modem in receiving mode, the data will go into transmit buffer memory. Transmission will start immediately when the radio channel is free, depending on the RX/TX priority setting of the radio modem:

a) TX-priority ON, immediately start transmitting the data sent by the DTE or

b) RX-priority ON, continue in receiving mode and buffer the data sent by the DTE. The buffered data will be transmitted when the radio channel is free (when the modem is not in the receiving state).

Terminal equipment can be also connected to the serial port of the repeater station. If the radio modem is already receiving a message to be forwarded, the data coming simultaneously from the serial port will be buffered until the store-and-forward procedure has been completed.

8.7 Factors affecting to the quality/distance of the radio connection

- Power of the radio transmitter
- Sensitivity of the radio receiver
- Tolerance of spurious radiation's of the radio modulating signal
- Gain of transmitting and receiving antennas
- Antenna cable attenuation
- Antenna height
- Natural obstacles
- Interference caused by other electrical equipment

The transmitter power of the base model of SATELLINE-3AS NMS is 1 W (maximum) and the sensitivity of the receiver is typically better than -115 dBm. Thus in a flat area and in free space with a 1/4 wave antenna (with antenna gain of 1dBi) and antenna height of 1 m communication distances app. 3 to 4 km can be achieved. Distances may be considerably shorter in situations where there are metallic walls or other material inhibiting the propagation of radio waves.

Over long distances, increasing antenna height can often solve problems caused by natural obstacles. A ten-fold increase in distance can be achieved by using antennas with higher gain. Frequent topographical variations over long distances may require that at least one of the antennas be raised to a height of 10 to 20 m.

If the antenna cable is more than 10 meters long it is necessary to use a low loss cable (< 0.7 dB /10 m) in order not to waste the antenna gain. Adding a repeater station can also solve problematic radio connections. In systems with many base stations the RSSI signal can be used to assist in choosing the base station with the best signal. A communications network can also be built with a combination of cables and radio data modems.

In mobile applications the range of operation can be increased by dividing the transmitted data into shorter e.g. 50...200 bytes blocks and by re-transmitting the defected blocks.

A sufficient safety margin can be obtained by testing the communication path by using extra 6 dB attenuation at the antenna connection and with slightly less effective antennas than the ones planned to be used in the final system.

8.8 Radio field strength

Radio signal strength must be good enough for successful data transfer. Wherever the field strength is above a certain level, the operational results are very good. Below this level, a few dB margin areas occur in which errors begin to be generated by noise and interference that will eventually lead to connection losses.

The field strength is at its optimum level in open space, although increasing the distance will still reduce it. It should also be noticed that open space may have different environmental and external factors compared to another place - and that the effects on transmission quality must be taken into account when planning the system.

Ground, ground contours and buildings cause attenuation (loss of energy through absorption) and reflections of radio waves. Buildings reflect radio waves and therefore the affects of attenuation are not as acute when transmission is over a short distance.
However, the reflected waves will often be a bit delayed and when combined with the direct radio waves they interact in either weakening or strengthening way. This causes the fading effect in mobile systems. The attenuation may even reach 40 dB, typically less.

8.9 Remarks concerning the 869 MHz frequency band

It is the recommendation ERC/REC 70-03 (available on the site www.ero.dk) created by the radio communications committee of CEPT, which sets the technical requirements for the licence exempt use of short range devices on harmonized frequency bands around the Europe.
CEPT members (spectrum authorities) have to either follow the recommendation in their frequency management or inform the CEPT radio communications committee about any restrictions. Those national restrictions are listed and attached to the ERC/REC 70-03 document.
According to the recommendation, the frequency band 869.400…869.650 MHz is reserved for use of license free radio appliances. The application of this recommendation varies in each country and for this reason local regulations concerning this frequency range must always be checked.

The sub-band 869.400-869.650 MHz is specified for 0.5 Werp (effective radiated power, in reference with a half wave dipole antenna, 0 dBd = 2.15 dBi). On this band, there are 10 pcs

of 25 kHz channels available: 869.4125, 869.4375, 869.4625, 869.4875, 869.5125, 869.5375, 869.5625, 869.5875, 869.6125 and 869.6375 MHz.
When calculating the radiated power, antenna cable attenuation and antenna gain must be taken into account. For example: when the antenna gain is 10 dBd and the antenna feeder cable attenuation is –3dB, the maximum allowed transmission power is 100 mW (+20 dBm). It should be noticed that by increasing the gain of the antennas, connection distance can be increased. This is due to the fact that the transmitting power remains constant, but the added antenna gain in the receiving end enables reception of weaker signals than otherwise possible.

System designers must also take into account that at the frequency range of 869.4…869.65 MHz the allowed transmitter duty cycle is 10% of the time (transmitter can be ON for up to 10% of the cycle time, maximum continuous transmitting time is 36 s).
Whether this limit is exceeded or not, depends on the protocol used.

Currently, the default settings of SATELLINE-3AS(d) 869 are:

- Output power = 500 mW
- Low limits of frequency bands 1 and 2 = 869.4125 MHz
- High limits of frequency bands 1 and 2 = 869.6375 MHz
- Centre frequency = 869.0125 MHz
- Operating frequency = 869.4125 MHz

9 TESTS

9.1 Test messages

The radio modem can be set to transmitting mode with two kinds of test messages - the *Short block test* and the *Long block test*. These can be utilized for example when directing antennas during system installation.
It is recommended to use the following data speed at the serial port of the receiving radio modem: 38400 bps @ 25 kHz radio channel spacing and 19200 bps @ 12.5 kHz.

The test transmissions can be started and stopped in the *Programming menu*, LCD menu or SATEL NMS PC program.

9.1.1 Short block test

In this test mode the radio modem sends a test message that is preceded by a consecutive serial number and terminated by the Line Feed character. The short data block transmission is followed by a 200 ms delay after which the transmission sequence will be repeated until the test is stopped.
Short data block test is suitable for running data communication tests. Error-free reception of data can be monitored using a terminal program, for example *SaTerm Lite*.

Example of a short data blocks:

```
$test3AS VHF ,0,1,S/N:0000000000, test line of SATELLINE – 3AS VHF ,E99C
```

9.1.2 Long block test

In this test mode the radio modem transmits test message continuously for 40 s. Then the transmitter is switched OFF for a 10 seconds break. This transmission sequence is repeated until the user stops it.
This test can be used in order to measure the transmitter output power, standing wave ratio (SWR) of the antenna system or received signal strength (RSSI level) at the receiver stations.

NOTIFICATION

When Long block test is used with the full output power (10 W) of SATELLINE-3AS NMS Epic, the radio modem must be the version equipped with a cooling element.
If the Epic doesn't have the cooling element, maximum allowed Tx output power in Long data test is 1 W.

Example of a long data blocks:

```
$test3AS VHF ,0,1,S/N:0000000000, test line of SATELLINE – 3AS VHF ,E99C
$test3AS VHF ,0,2,S/N:0000000000, test line of SATELLINE – 3AS VHF ,E758
$test3AS VHF ,0,3,S/N:0000000000, test line of SATELLINE – 3AS VHF ,E2E4
```

9.1.3 Monitoring the test transmission using the receiver

The user can monitor the quality of the received data by visually inspecting the received data stream. The packet identifier number helps to keep track of possibly lost messages. Error-free reception of data can be checked by using a suitable terminal program, which may calculate BER (Bit Error Rate) or PER (Packet Error Rate) performance of the radio links.

The signal strength of the reception can be monitored also by:

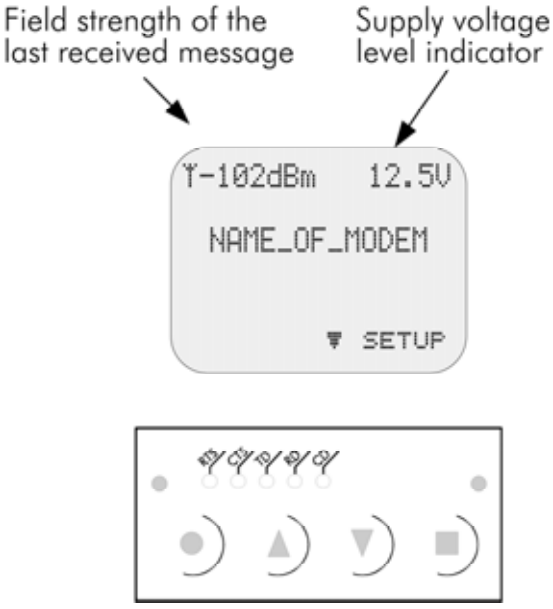
- Enquiring the RSSI level from the radio modem by using the SL command (SL@R?). In that case the SL commands must be enabled in the radio modem setup.
- Monitoring the LCD display (models equipped with the LCD)

10 LCD & PUSH BUTTONS

SATELLINE-3ASd NMS includes an LCD (Liquid Crystal Display) that indicates the status and basic settings of the radio modem. LCD and the four push buttons enable easy access to the radio modem settings without a need for an external terminal program. This feature is especially handy on the field conditions.

10.1 LCD after power-up

The picture on the right shows the outlook of the LCD after the power-up i.e. the idle state of the radio modem.



The RSSI meter on the upper left corner indicates the received signal strength (RSSI) in dBm units. The value will be shown for 5 seconds after the last message has been received. The reading "---dBm" means that no signal from any other SATELLINE-3AS NMS radio modem is detected.

The voltage meter on the upper right corner indicates the supply voltage of the radio modem in Volts.

There are two options to proceed from this view:

- Info pages - Press the ▼ -button to view the info pages.
- Main menu - Press the *SETUP* -button to enter to the main menu in order to modify the settings.

10.2 Info pages

Scrolling between the info pages is done by pressing ▼ and ▲ -buttons. The info pages show the following settings:

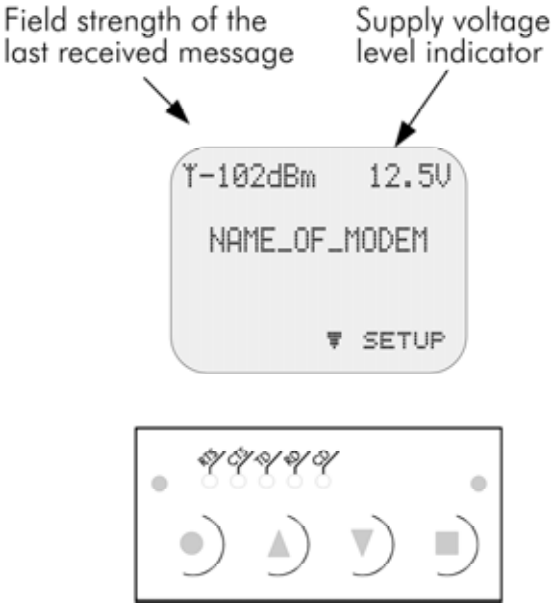
1. Transmitter: frequency and power
2. Receiver: frequency and RSSI threshold
3. Serial port 1 function, type, speed and character
4. Serial port 2 function, type, speed and character
5. SW (software) version number
6. RF (radio) version info
7. HW (hardware) version info
8. Serial number

10.3 How to use menus

The main menu is used to select the desired submenus. The setting modifications are performed using these submenus. It is possible to jump back to the previous (higher) level in the menu hierarchy by pressing the ”BACK”-button at any time (same button serves also as CANCEL and EXIT depending on the particular submenu).

The ▸ symbol on the left column indicates the active selection or the current value of the setting.

Pressing ▲ or ▼ button either scrolls in the menu or modifies parameters with numerical values consisting of digits. Use ▲ or ▼ button until the desired value is reached.
The inverted text shows the cursor line. ”SELECT/OK”-button confirms the selection.



10.4 Menu structure

10.4.1 Main menu

The main menu allows the user to choose from several functional parameter groups. The sub-menu choices will appear in the following order:

- Radio settings
- Network mode
- Serial Port 1 settings
- Serial Port 2 settings
- Handshaking
- Additional settings
- Tests & Counters
- Restore Factory settings

Each of the submenus is described in detail in the following paragraphs.

10.4.2 Radio settings

The submenu contains the following radio related parameters:

- Frequency
- Tx Power
- RSSI Threshold
- FEC
- Tx Delay
- Sync Interval
- Error check
- Rx Delay

The following table describes each parameter, indicates the default value and if applicable, defines the allowed value range.

MAIN MENU										
Radio settings										
Frequency			TxPower	RSSI Threshold	FEC	Tx Delay	Sync Interval		Error Check	Rx Delay
TX & RX freq.	TX freq.	RX freq.					Set to Default	Customize		
X.X MHz ▼▲	X.X MHz ▼▲	X.X MHz ▼▲	►10 mW 20 mW 50 mW 100 mW 200 mW ►500 mW ►1 W ▼▲	-80 dBm | -87 dBm | ►-118 dBm ▼▲ [step size -1 dBm]	►FEC OFF ►FEC ON ▼▲	0 ms | 9999 ▼▲ [step size 1 ms]	SELECT [default value 21845 bytes]	0 | 65535 ▼▲ [step size 1 byte]	►OFF PARTIAL ►FULL ▼▲	0 ms | 65535 ▼▲ [step size 1 ms]

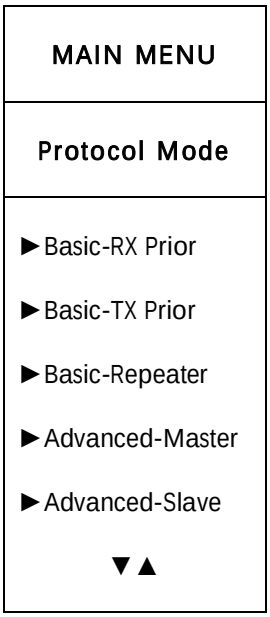
Note: X.X MHz is shortened from the actual display of XXX.XXXXXX MHz
▼▲ scroll value up or down OR select from list
► indicates selected value

10.4.3 Protocol mode

The submenu allows the setting of the network mode used by the radio modem for transmitting and receiving data on the radio modem network. The following options can be chosen:

- Basic - RX Priority [default value]
- Basic - TX Priority
- Basic - Repeater
- Advanced - Master
- Advanced - Slave

NOTE: Each of the options listed above activates the appropriate function, thus, there are no value ranges to consider.



10.4.4 Serial Port 1 -settings

The submenu allows modifying the settings of the serial port 1. This main menu option will list the following options to choose from:

- Port function type
- Serial port speed
- Number of data bits
- Parity
- Number of stop bits

MAIN MENU				
Serial Port 1				
PORT1 FUNCTION	PORT1 DATA SPEED	PORT1 DATA BITS	PORT1 PARITY	PORT1 STOP BITS
►OFF ►DATA ►NMS ▼▲	►1200 bps ►2400 bps ►4800 bps ►9600 bps ►19200 bps ►38400 bps ▼▲	►7 bit data ►8 bit data ▼▲	►None parity ►Even parity ►Odd parity ▼▲	►1 stop bit ►2 stop bit ▼▲

10.4.5 Serial Port 2 -settings

The submenu allows modifying the settings of the serial port 2. This main menu option will list the following options to choose from:

- Port function type
- Serial port type
- Serial port speed
- Parity
- Number of stop bits

MAIN MENU					
Serial Port 2					
PORT2 FUNCTION	PORT2 TYPE	PORT2 DATA SPEED	PORT2 DATA BITS	PORT2 PARITY	PORT2 STOP BITS
►DATA ►NMS ▼▲	►RS232 ►RS485 ►RS422 ▼▲	►1200 bps ►2400 bps ►4800 bps ►9600 bps ►19200 bps ►38400 bps ▼▲	►7 bit data ►8 bit data ▼▲	►None parity ►Even parity ►Odd parity ▼▲	►1 stop bit ►2 stop bit ▼▲

10.4.6 Handshaking

The submenu allows modifying the settings of the handshaking parameters. This main menu option will list the following options to choose from:

- CTS line
- RTS line
- CD line
- Pause length

MAIN MENU			
Handshaking			
CTS line	RTS line	CD line	Pause length
►Clear To Send ►TX buffer state ▼▲	►Ignored ►Flow control ►RX control ▼▲	►RSSI threshold ►Data on channel ►Always ON ▼▲	►1 bytes | ►99 bytes ▲▼ [step size 1 byte]

10.4.7 Additional -setting

The submenu the user may enable or disable the use of SL commands with.

MAIN MENU
Additional
SL-commands
►OFF ► ON

10.4.8 Tests & Counters

Reset counters	Short Block Test	Long Block Test
NOTE: This option activates reset directly!	NOTE: This option activates test sequence directly and is stopped by pressing any button.	NOTE: This option activates test sequence directly and is stopped by pressing any button.

10.4.9 Restore factory settings

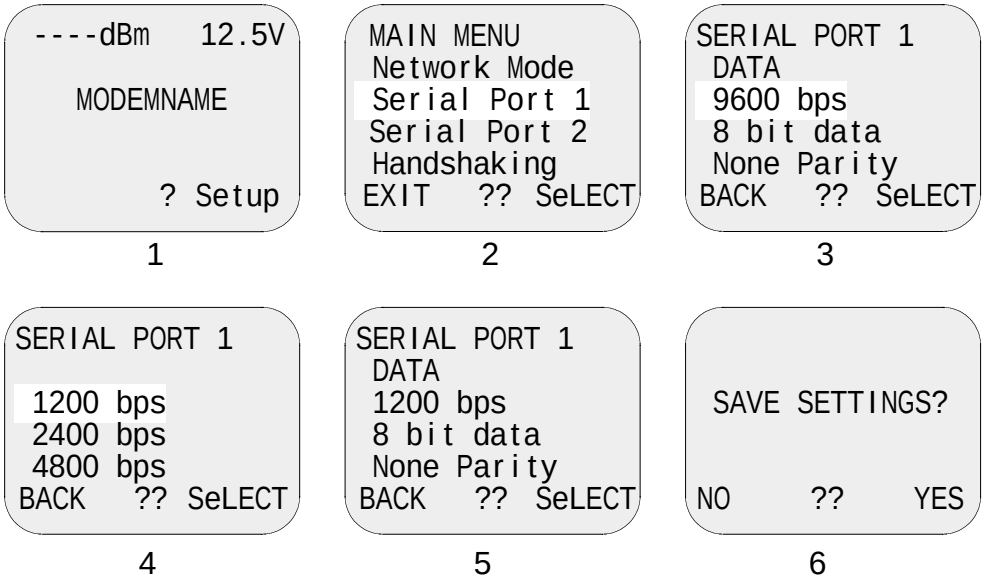
MAIN MENU
Restore Factory
Do you want to restore factory settings? NO YES

10.5 Example of changing a setting

The following example shows how to change any parameter value using the push buttons and the LCD display of the radio modem.

Example: The data speed of the Serial Port 1 is changed to 1200 bps by following the steps:

1. Go to SETUP – MAIN MENU by pressing the **SETUP** button.
2. Go to the Serial Port 1 submenu by scrolling with the ▼▲ buttons until the cursor is pointing at the Serial Port 1 selection. Press the **SELECT** button.
3. Go to the port speed submenu by scrolling with the ▼▲ buttons until the cursor is pointing at the data speed (bps) selection (9600 bps in this example). Press the **SELECT** button.
4. Select the desired value (1200 bps in this example) by scrolling with the ▼▲ buttons until the cursor is pointing at the correct selection. Press the **SELECT** button.
5. Press the **BACK** button and note that the display will now show the port speed as 1200 bps (value has been changed).
6. Press **BACK / EXIT** button until the **"Save settings?"** is displayed. Confirm the change by pressing **YES** or change back to the previous value by pressing **NO**. The display will now return to the main screen.

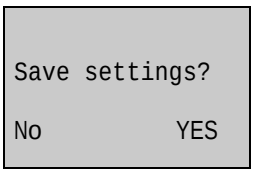


10.6 Saving the settings

After all desired modifications have been performed they MUST BE SAVED in order to make them permanent. This is accomplished by choosing ”EXIT” option from the main menu. The display shows a message (see below) asking for a confirmation for the performed modifications.

Option “YES” saves all modifications into the non-volatile memory inside the radio modem. Option ”NO” cancels all modifications performed and previous settings remain in the non-volatile memory.

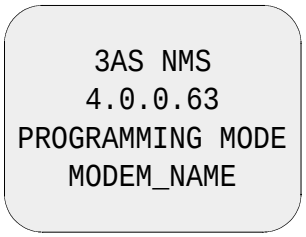
Press ”YES” to save all modifications into the non-volatile memory and ”NO”, if modifications are to be cancelled.



10.7 Special displays

10.7.1 Programming Mode display

LCD menu is disabled while the radio modem is in the *Programming mode* (see the next chapter). This is indicated by a display text "PROGRAMMING MODE" like the menu on the right presents.



11 PROGRAMMING MODE (TERMINAL MENU)

11.1 Programming Mode

The basic settings of the radio modem are fully configurable in the *Programming Mode*. The most recommended setup for changing parameters is CRS-9 cable, a power supply and the *SATEL NMS PC* program. NARS-1F adapter contains a switch to enable easy shifting into the *Programming Mode*. Other suitable terminal programs and cables may also be used.

The radio modem will shift into the *Programming Mode* by connecting the D-connector pin 12 to ground (GND) potential. With NARS-1F adapter this can be accomplished by moving the slide switch downwards.

In the *Programming Mode*, the radio modem will always use serial port **PORT1**, with settings 9600 bps, N, 8,1 (data transfer speed 9600 bps, no parity, 8 data bits and 1 stop bit).

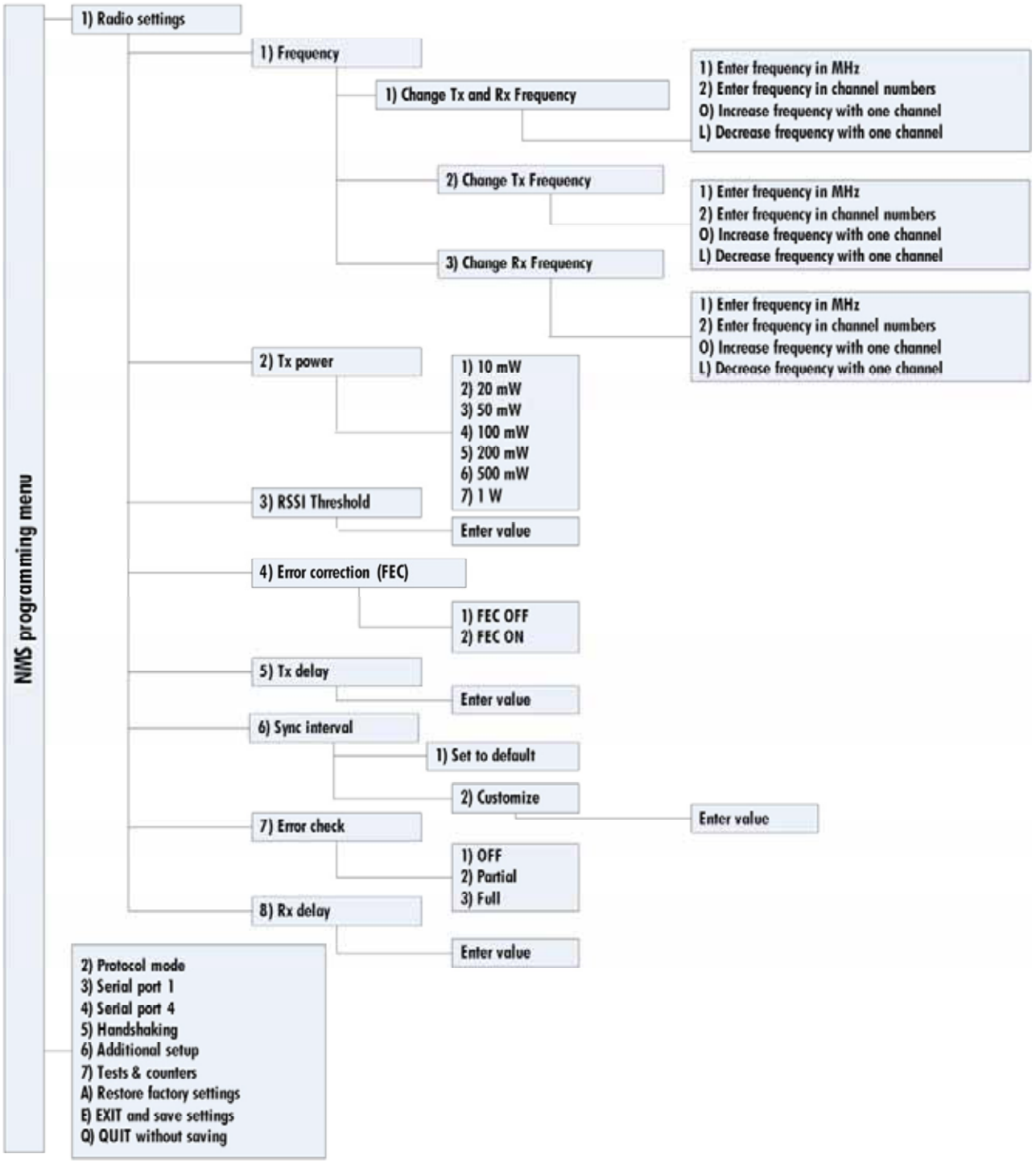
The radio modem will output the following *Programming menu* to the terminal (certain configuration settings might differ from the ones shown):

```
--------------------------------------------------------------------------------
    SATELLINE-3ASd NMS
    SW: version 4.0.0.63
    HW: AA01.03
    RF: TC4n
    Center frequency 468.200000 MHz / Channel spacing 25.000 kHz
    SERIAL: 050112345  Name: MODEM_NAME
--------------------------------------------------------------------------------

1 ) Radio Settings      TX frequency: 468.425000 MHz / TX Power 100 mW
                        RX frequency: 468.425000 MHz / FEC OFF /
                        RSSI Threshold -112 dBm / Error check OFF
                        TX delay 0 ms / Sync interval default / RX delay 0 ms
2 ) Protocol Mode       Basic - RX Priority
3 ) Serial Port 1       DATA / RS232 / 19200 bps / 8 bit data / None parity /
                        1 stop bit
4 ) Serial Port 2       NMS / RS232 / 9600 bps / 8 bit data / None parity /
                        1 stop bit
5 ) Handshaking         CTS Clear To Send / CD RSSI threshold / RTS Ignored /
                        Pause length 5 bytes
6 ) Additional Setup    SL-commands ON / LCD read-only OFF
7 ) Tests & Counters

A ) Restore factory settings
E ) EXIT and save settings
Q ) QUIT without saving

Enter selection >
```

11.1.1 Changing the settings in the Programming Mode

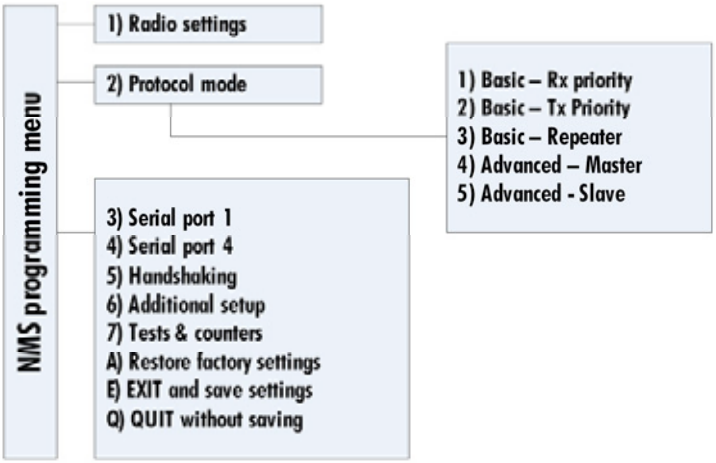
- Connect cables (RS-232 cable to PC COM port, power supply cable to power supply).
- Switch on the PC and start *SaTerm Lite* program (or other terminal program).
- Open a terminal window and then choose "Pr" (in case you are using some other terminal program, set the serial port parameters of the program as follows: 9600 bits/s, 8 data bits, no parity, 1 stop bit, which is always the default in *Programming Mode*).
- Connect PROG pin to ground (if using the NARS-1F adapter, slide the switch downwards), the radio modem shifts into the *Programming Mode*. The screen should look similar to the one shown in the picture below.
- Make desired changes to the settings.
- Save changes by pressing "E" in the main menu. If you don't want to save changes, press "Q".
- Disconnect PROG pin from ground (if using the NARS-1F adapter, slide the switch upwards), the radio modem returns to the *Data Transfer Mode*.

11.1.2 Radio settings

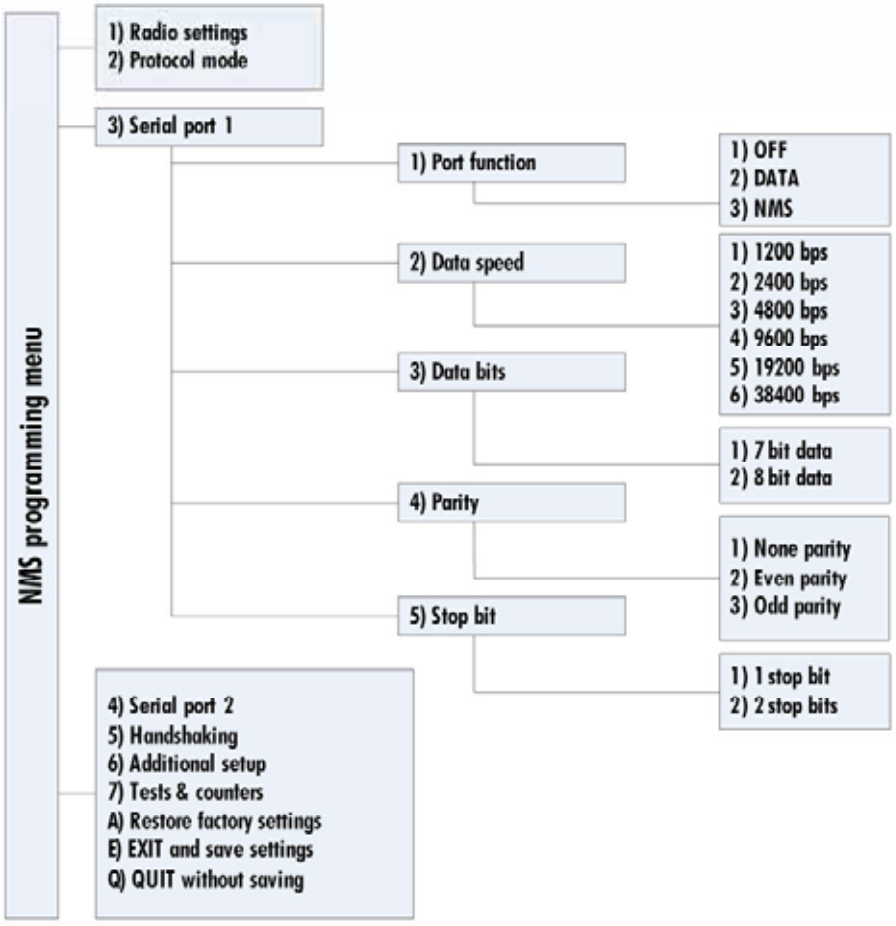


NOTE !
Adjustment of the active radio channel of the radio modem to frequencies other than those allocated and/or allowed by local authorities is strictly forbidden. Use or intended use of forbidden frequencies may lead to prosecution and penalties. SATEL is not responsible for any illegal use practiced with any devices manufactured and/or sold by SATEL and is not liable to pay any damages or compensation caused by such illegal use.

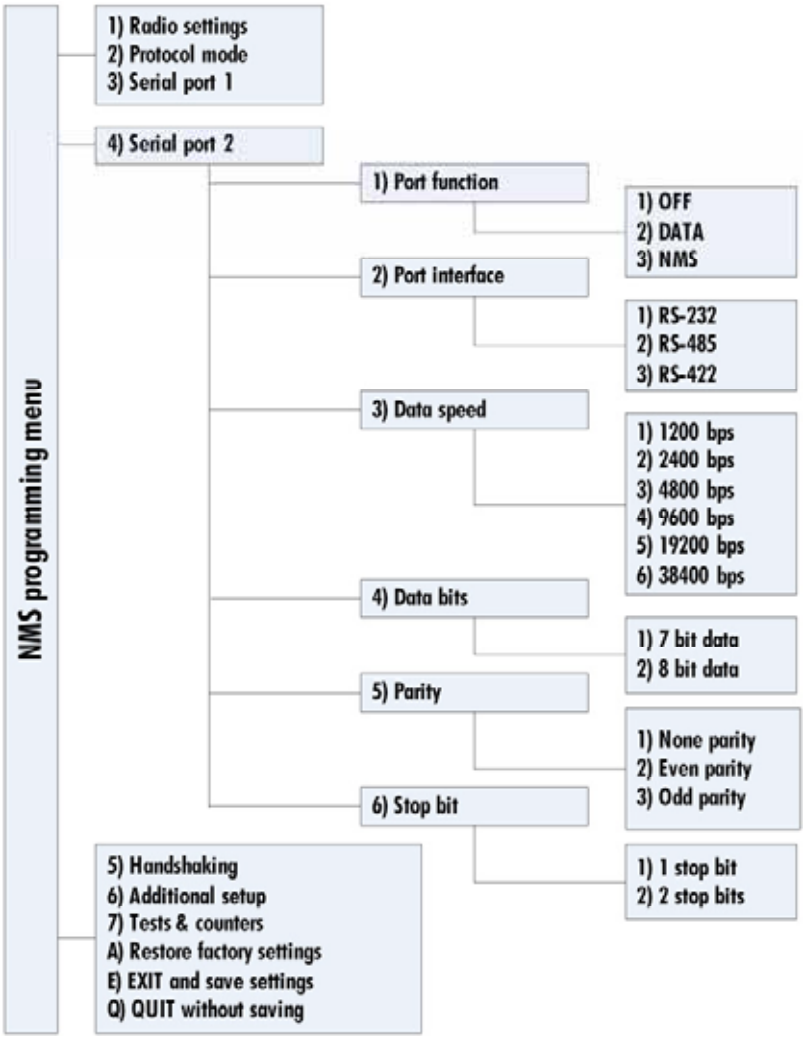
11.1.3 Network Protocol mode -settings



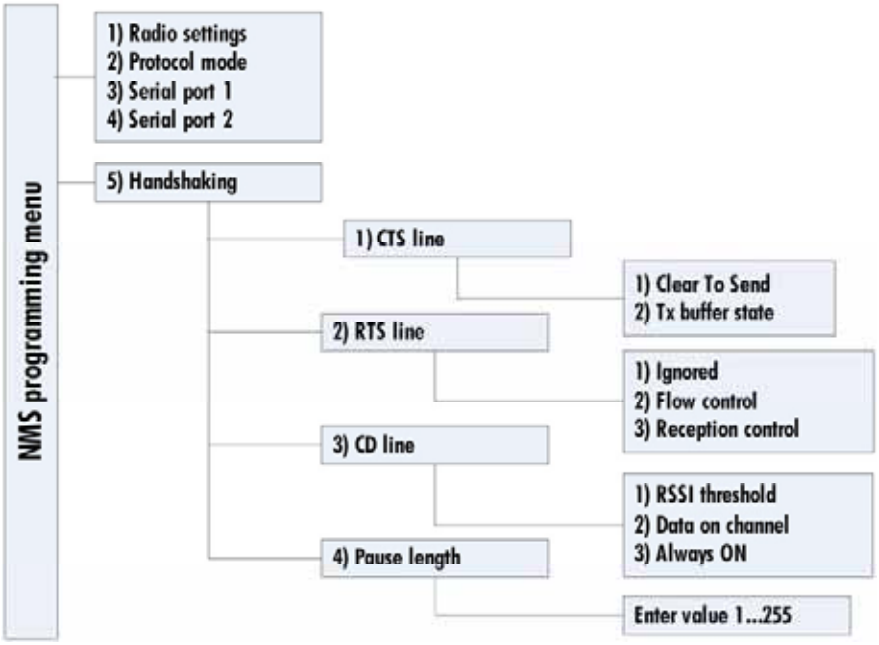
11.1.4 Serial port 1 -settings



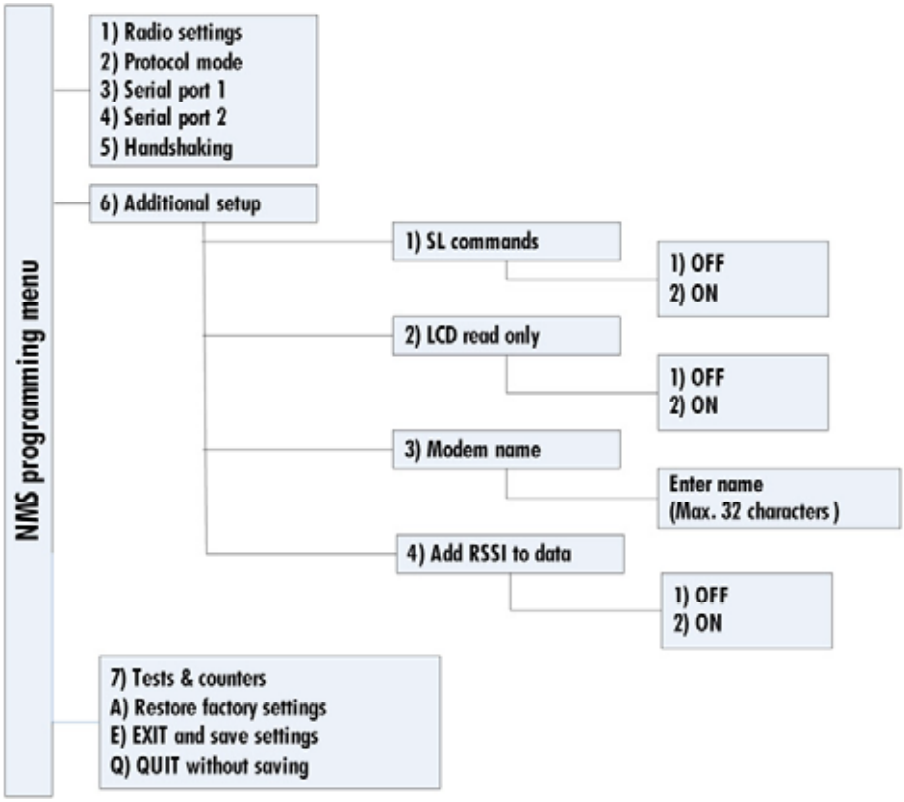
11.1.5 Serial port 2 -settings



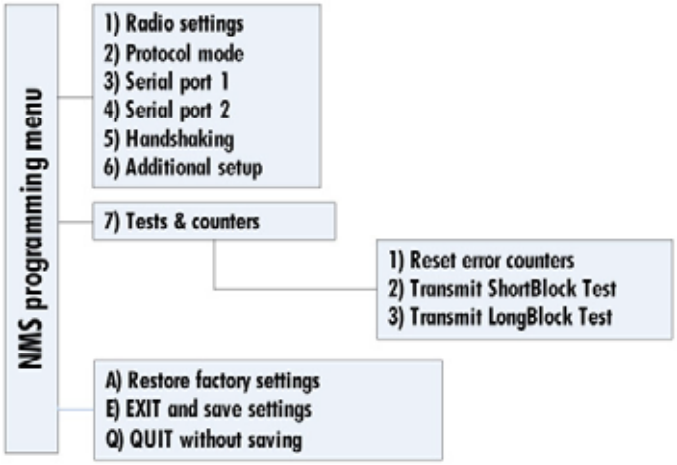
11.1.6 Handshaking -settings



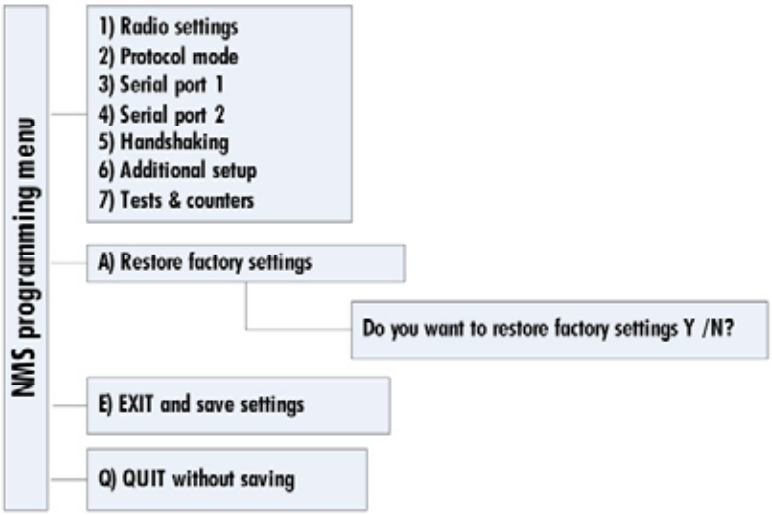
11.1.7 Additional -settings



11.1.8 Tests and counters -settings



11.1.9 Restoring factory settings EXIT and save and QUIT without saving -settings


NMS programming menu
1) Radio settings
2) Protocol mode
3) Serial port 1
4) Serial port 2
5) Handshaking
6) Additional setup
7) Tests & counters
A) Restore factory settings
Do you want to restore factory settings Y /N?
E) EXIT and save settings
Q) QUIT without saving

The original settings of the radio modem can be restored by selecting “A” in the Main menu and confirming ”Y” (YES) on the prompt. By pressing any other button current settings will remain active. The modem will ask this question twice to make ensure that this is a valid command.

Restoring is confirmed by pressing ”Y” (Y=YES) or cancelled by pressing ”N” (N=NO). Also pressing ”ESC” button at any point in the procedure will return the display to the previous (next higher) menu level without restoring factory settings.

All modified settings must be saved into the permanent non-volatile memory of the radio modem before switching out of the *Programming Mode*. Selecting the main menu selection *E) EXIT and save* settings automatically saves the settings.

NOTICE! To switch the radio modem back into *Data Transfer Mode* the MODE-pin of the D-connector (D-15 pin 12) must be disconnected from ground (GND).

12 SOFTWARE UPDATE

The software of SATELLINE-3AS(d) NMS is stored in a flash memory. If needed, the software can be updated. Reprogramming of the actual firmware of the radio modem is performed by running the appropriate .exe file that includes the desired version of the software. The radio modem must be in the *Programming Mode* while performing the flash update procedure.
For example, SATELLINE_3AS_NMS_sw_4_1_2.exe is the software file for updating the software version 4.1.2 in the SATELLINE-3AS NMS radio modems.

1. Connect RS-232 cable to PC COM-port and Port 1 of the radio modem.
2. Connect the power supply cable.
3. Connect PROG pin to ground (if using the NARS-1F adapter, slide the switch away from the radio modem).
4. Switch the power ON, the radio modem shifts now into the *Programming Mode*.
5. Run the desired flash update file and follow the instructions.
6. After the update, remember to disconnect the PROG pin (if using the NARS-1F adapter, slide the switch towards the radio modem). The radio modem returns to the *Data Transfer Mode* using the updated software version.

WARNING! THE FLASH UPDATE PROCEDURE MUST BE CAREFULLY CONDUCTED. IF AN INTERRUPTION (FOR EXAMPLE POWER LOSS) OCCURRED DURING THE TRANSFER OF THE ACTUAL PROGRAM CODE, THE RADIO MODEM WILL NO LONGER FUNCTION AND IT MUST BE SENT TO AN AUTHORIZED SERVICE REPRESENTATIVE FOR FLASH UPDATE.

13 SL-COMMANDS

Controlling the terminal device (DTE) can instruct the radio modem to make an action. This is accomplished with the help of the SL commands, which can be used during data transfer in the *Data Transfer Mode*. For example, DTE may change the frequency or the output power of transmitter, or DTE may enquiry current settings from the radio modem.
SL commands must be enabled before they can be used by setting the *SL commands* parameter ON in the *Programming Mode*.

An SL command is a one continuous string of characters, which is separated from other data by pauses that are at least three (3) characters long. The continuous here means that there are no pauses between the adjacent characters inside the SL command on the serial line.
No extra characters are allowed at the end of an SL command. The serial interface settings are the same as in normal data transfer.

The syntax of an SL command is: **S L <Command> <CR> <LF>,** where:

<Command> is the actual character string defining the actual command.
<CR> is Carriage Return (ASCII character 13, 0x0d in hexadecimal)
<LF> is LineFeed character (ASCII character 10, 0x0a in hexadecimal).

Note that the use of <LF> is optional the radio modem does not require it.

If multiple SL commands are sent to the radio modem the next command can be given after receiving the response ("Ok" or "Error" or the value) of the proceeding command. In addition, it is recommended to implement a timeout to the terminal software for recovering the case when no response is received from the radio modem.

The radio modem handles all data strings with the prefix 'SL' as SL commands. Invalid SL commands are ignored. Note also that the radio modem does not transmit the SL commands.

The radio modem responses using the following format:

<STX>SL<Response Data><ETX><CR><LF>, where
<STX> Start of Text character (0x02 in hexadecimal)
<Response Data> is a character string, the actual reply to the previous SL command.
The radio modem acknowledges all commands by replying "**OK**" (command carried out or accepted) or the requested value, or an "**ERROR**" (command not carried out or interpreted as erroneous) message.
<ETX> End of Text character (0x03 in hexadecimal)

The frame characters ease the implementation of parser software for the DTE.

In case the radio modem is receiving a message, entering an SL command to the radio modem will terminate the reception and the SL command is processed.

When the power of a radio modem is switched off, the configuration settings of a radio modem always return to values defined initially using the *Programming Mode*, thus resetting any settings changed using SL commands during power on. It is however possible to save changed settings permanently by using a special SL command.

In case you need more information on the time delays related to the use of SL commands, please contact the manufacturer.

13.1.1 Frequency related SL commands

Command	Description	Response
SL&F=nnn.nnnnn	Set both TX and RX frequencies to nnn.nnnnn MHz	"OK" or "ERROR"
SL&F?	Get TX and RX frequencies	"TX nnn.nnnnn MHz, RX nnn.nnnnn MHz" or "ERROR"
SL&FR=nnn.nnnnn	Set RX frequency to nnn.nnnnn MHz	"OK" / "ERROR"
SL&FR?	Get RX frequency	"nnn.nnnnn MHz"
SL&FT=nnn.nnnn	Set TX frequency to nnn.nnnnn MHz	"OK" / "ERROR"
SL&FT?	Get TX frequency	"nnn.nnnnn MHz"
SL&C?	Get Centre Frequency	'nnn.nnnnn MHz'
SL&+=nn	Set both RX and TX frequencies nn channels above the Center frequency Frequency = Center frequency + nn * Channel spacing, where nn=[0...Number of channels/2]	"OK" or "ERROR"
SL&-=nn	Set both RX and TX frequencies nn channels below the Center frequency Frequency = Center frequency – nn * Channel spacing, where nn=[0…Number of channels/2]	"OK" or "ERROR"
SL&N?	Get current frequency deviation from center frequency as channels (Frequency – Center frequency)/Channel spacing	"+nn" or "-nn"
SL&W?	Get Channel spacing	"12.5 kHz", "20 kHz" or "25 kHz"

13.1.2 Radio parameters

Command	Description	Response
SL@R?	Get the minimum field strength (RSSI) of the last received message. Note: Value is available 5s after reception. SATELLINE-3AS-NMS Epic returns the stronger value of two receivers.	"-xxx dBm", where xxx is 080….118
SL@P=xxxxx	Set the RF output power, where xxxxx is the decimal value of the intended power in mill watts. Only values matching exactly the programmed power levels are accepted.	"OK"
SL@P?	Get RF output power.	”xxxxx mW”, where xxxxx is a decimal value the output power of the transmitter.
SL@T=-xxx	Set the minimum power level of the signal to be received (="Signal Threshold level i.e. squelch), where xxx is a decimal value of the new intended level in dBm.	"OK"
SL@T?	Get current "Signal Threshold Level"	"-xxx dBm", where xxx is 50….118
SL@F?	Get the current RSSI. If no signal is being received, then current noise level is shown.	"-xxx dBm", where xxx is 50….118

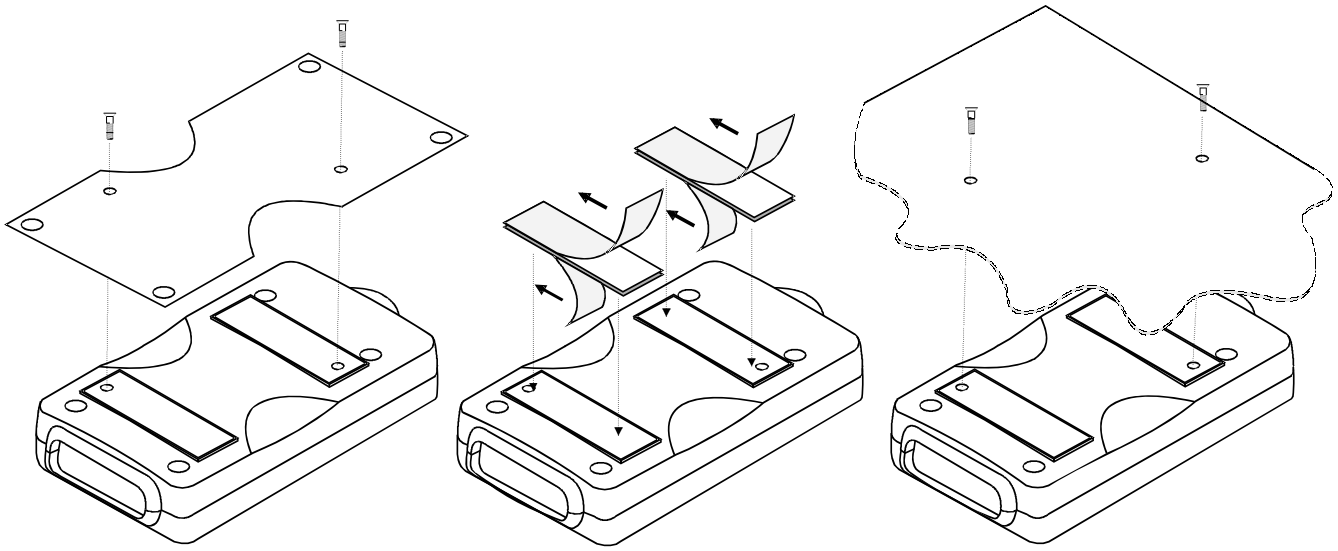
13.1.3 Other SL commands

Command	Description	Response
SL**>	Save all current settings as permanent.	"OK"
SL%V?	Get software revision information	"Vn.n.n.n"
SL!H?	Get radio board version	”nnnnnnnn”
SL%S?	Get modem serial number	"yywwnnnnn"
SL%I?	Get modem user given name	”nnnnnnnn”
SL%S?	Get modem serial number	"yywwnnnnn"
SL%P=1	Display *Programming menu*. Note use 'E' or 'Q' to quit. Modem flash update is not possible.	Displays the *Programming menu*
SL%T?	Get test mode	"0","1" or "2"
SL%T=n	Set test mode, where n is: 0= test mode off 1= short block test 2= long block test	"OK"
SL@X?	Request the RX delay.	"nnnn ms"
SL@X=nnnn	Set the RX delay in ms.	"OK"
SL!V?	Get the name of the product	For example "3AS VHF" for SATELLINE-3AS VHF
SL%M=1	Swap the DATA and NMS ports	“OK” from new DATA port
SL@D=nnnnn	Set the TX delay in ms	“OK”
SL@D?	Request the TX delay.	"nnnn ms"

14 INSTALLATION

14.1 Installation of the radio modem

The radio modem should be installed with the installation accessories supplied with the radio modem. There is also available an installation component for mounting the radio modem to a DIN rail.



1. Installation with the installation plate supplied with the radio modem. The installation plate is fastened to the backside of the radio modem.
The installation plate can be mounted using the holes provided on the plate.

2. Installation using the Velcro-tape provided with the radio modem.

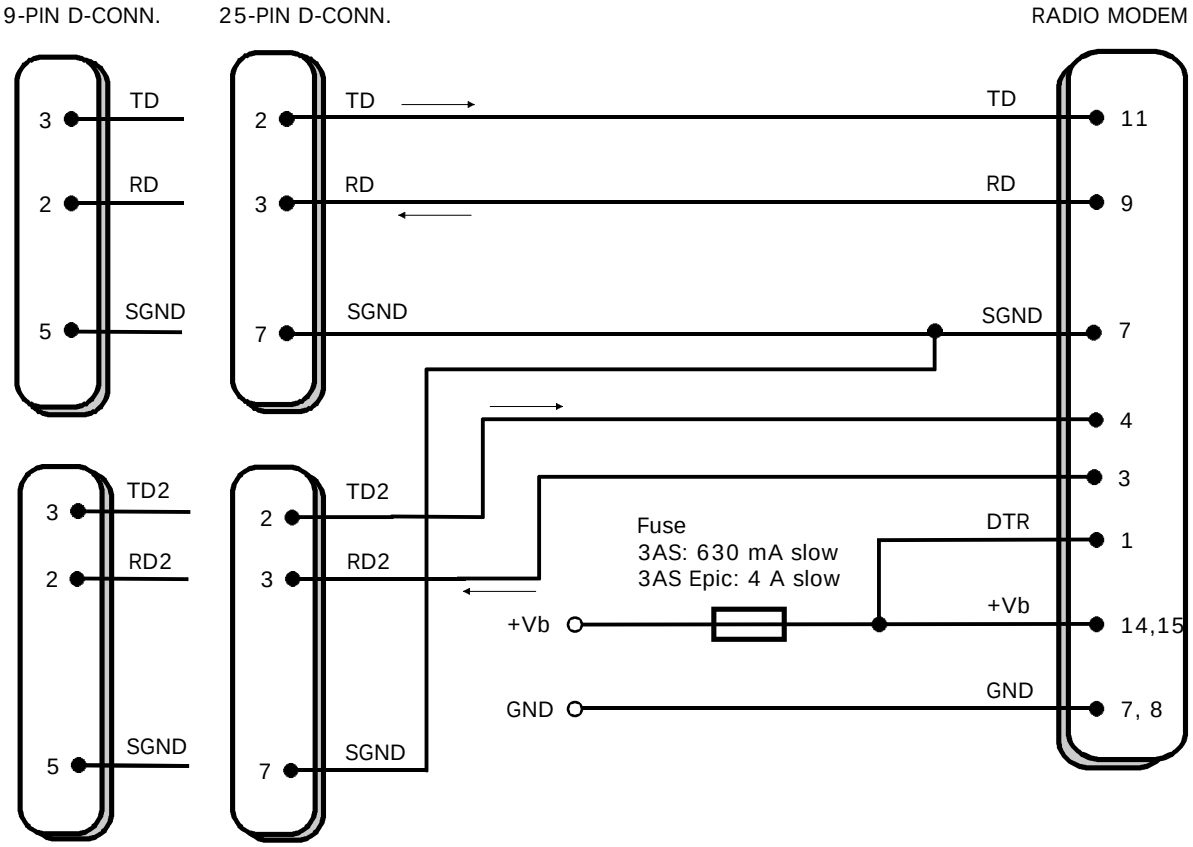
3. Installation can also be made directly to customer's equipment.

NOTE!
When selecting a suitable location for the radio modem it must be ensured that no water can get into the radio modem under any conditions. Direct sunlight is also to be avoided. It is not recommended to install the radio modem on a strongly vibrating surface. Suitable dampening and/or isolation materials should be used in cases where the installation surface will be subjected to vibration.

14.2 Wiring

14.2.1 RS-232 wiring - both Ports 1&2 connected (DATA and NMS in use)

A typical connection between a radio modem and the PC serial ports (RS-232) is depicted in the schematic below. One of the ports serves as the DATA port while the other is for NMS.

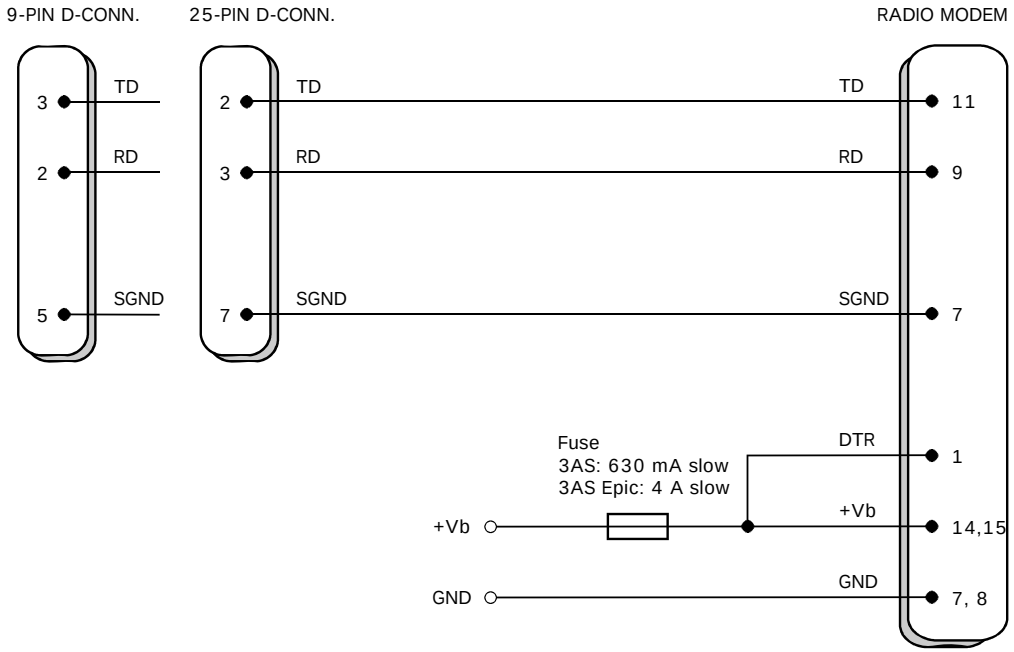


NOTE!
When installing the cables of the serial interface, the operating voltage of all devices must be off (POWER OFF condition).

Due to the greater current consumption of SATELLINE-3AS-NMS Epic operating voltage must be connected to pins 14 AND 15, and ground to pins 7 AND 8. Correct fuse rating is in this case 4 A (SLOW FUSE).

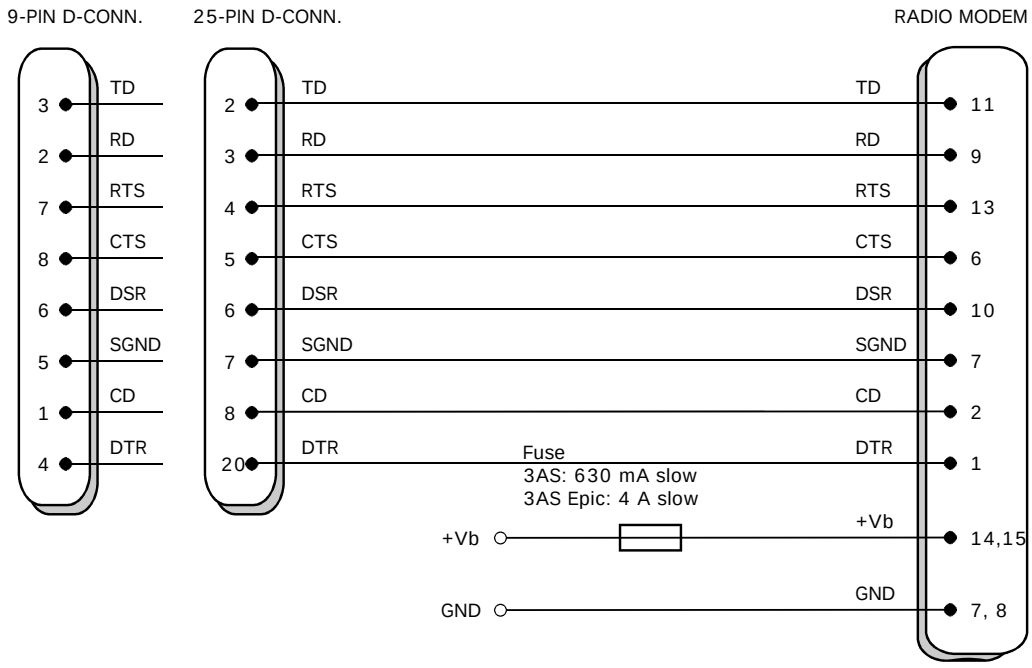
14.2.2 RS-232 wiring - Port1 without handshaking

The simplest connection to PC serial port (RS-232) is depicted in the schematic below.

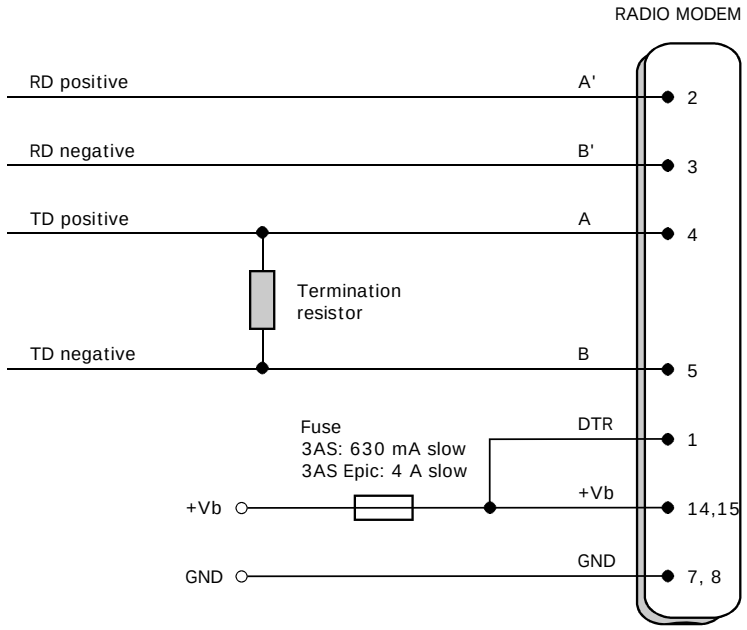


14.2.3 RS-232 wiring - Port1 and handshaking signals connected

A typical connection between the Port 1 of the radio modem and the PC serial port (RS-232) using the handshaking signals is depicted in the schematic below.



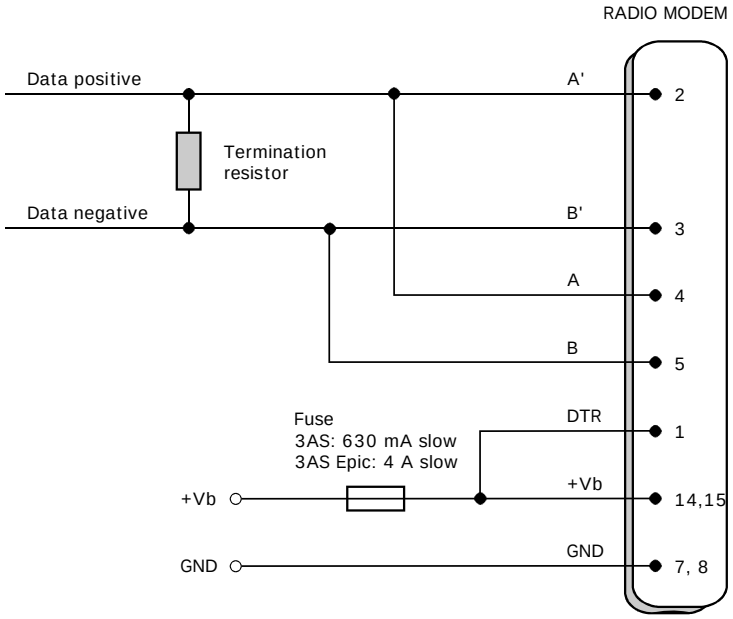
14.2.4 RS-422 wiring



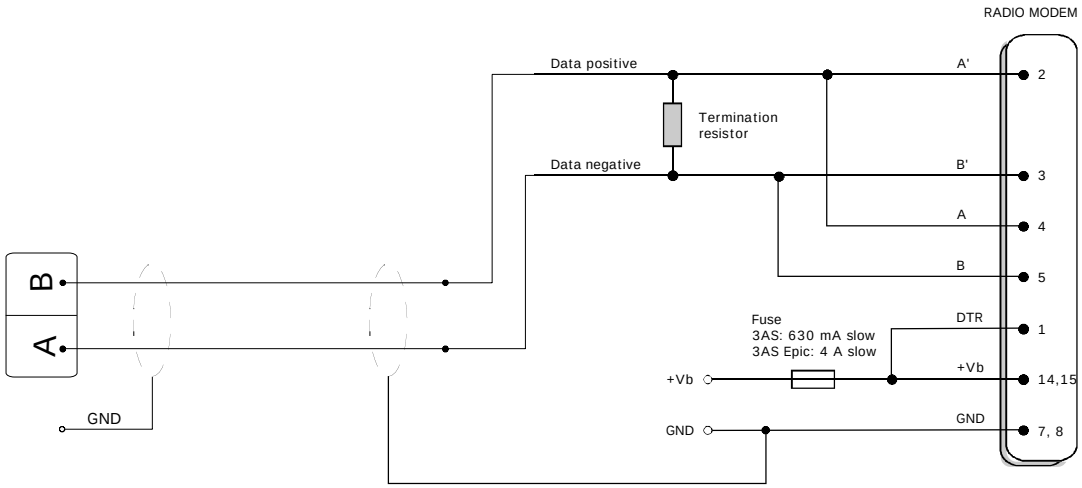
If the transmission lines are long the receiving end of the lines must be terminated using a separate termination resistor (typical values range from 100 -120Ω depending on the characteristic impedance of the transmission line).

14.2.5 RS-485 wiring

Both ends of the transmission line must be terminated by connecting a separate terminating resistor between the positive and negative signal wire. Typical values range from 100 – 120Ω depending on the characteristic impedance of the line.



14.2.6 Profibus wiring



14.2.7 Fuse

A proper fuse must be connected in between the radio modem and the power supply, see below:

	Fuse
SATELLINE-3AS(d) NMS, NMS 869, VHF	1A slow
SATELLINE-3AS(d) NMS Epic	4 A slow
SATELLINE-3AS(d) VHF - 5W model	4A slow

14.2.8 Power supply

The allowed operating voltage is +9 … +30 V_{DC}. (SATELLINE-3AS(d) NMS Epic +11.8 … +30 V_{DC}). The radio modem must only be connected to a power supply with an adequate current output (power rating minimum is 10W, with the Epic model 50W). The pins 15 and 14 of the D-connector are connected to the positive power supply line. The pins 8 and 7 of the D-connector are connected to negative power supply line (ground).

The DTR line of the radio modem (D-15 connector Pin1) can be used as an ON/STANDBY switch, which helps to conserve battery power and prolong the operational time in battery-powered applications. The radio modem is:

- ON if the voltage at the DTR pin is more than +2VDC.
- OFF in the Stand-by Mode if the voltage at the DTR pin is less than +0.6VDC.

Note: if the DTR pin is not connected, the radio modem is ON.

NOTE! There is a galvanic connection between signal ground (SGND, pin 7), ground (GND, pin 8), outer conductor of antenna connector and modem casing.

14.3 Antenna installation

NOTE!
Because of the high transmission power of SATELLINE-3AS(d) NMS Epic radio modem, only an external antenna is allowed. A whip-antenna directly connected to the antenna connector must not be used.

14.3.1 Hand-held equipment

¼-wave antenna (wavelength at frequency of 450 MHz is approximately 70 cm)
Helix-antenna

Antennas are installed directly to the TNC type antenna connector at the upper part of the radio modem.

14.3.2 Mobile equipment

¼-wave antenna
½-wave antenna

The ideal installation position is vertical, and there should be at least 0.5 m of free space around the antenna. In small systems a ¼-wave antenna is sufficient. A separate ground plane should be placed under the antenna (vehicle rooftop or the engine hood or trunk door are usually suitable). In problematic cases the most suitable type is a ½-wave antenna. It can be installed directly at the top of a pipe with the added benefit of gaining as much as free space around the antenna as possible. In cases that the antenna cannot be directly connected to the TNC connector of the radio modem, a coaxial cable with 50Ω impedance must be used between the antenna and the TNC connector.

14.3.3 Base stations

Omni-directional antennas (¼- , ½- or 5/8-wave antenna)
directional antennas (yagi /multi-element antenna or corner antenna)

The antenna should be installed in a vertical position. The exact location of the antenna depends on several factors, such as the size of the overall system and the coverage area terrain contours. A rule of thumb is that the base station antenna should be located at the highest point of the coverage area and as close to the centre of the coverage area as possible. The base station antenna can also be located inside a building, if the walls of the building do not contain metal.

14.3.4 General antenna installation instructions

The reliability and the achievable coverage of useful signal strength can be severely affected by the positioning of the antenna. Antenna and cable connectors should have gold-plated pins and sockets, abuse of low quality connectors can lead to eventual oxidation of the connector surfaces which in turn may degrade the contact and cause additional attenuation. Good quality tools and materials must be used when installing radio modems, antennas and cables. The weather tolerance of the materials used must also be taken into account. Installed materials must withstand all foreseeable weather conditions (frost, excess sun, direct UV-radiation, seawater etc.). Also possible environmental pollution must be considered (acids, ozone etc.).

Antennas must be installed well away from metallic objects. In the case of small antennas this distance should be at least ½ m. With large antennas the distance should be >5 m and in case of repeater antenna combinations >10 m.

If the system contains a large number of radio modems, the best location for an antenna is the highest point of a building and possibly an additional antenna mast. If a separate antenna mast is used, the antenna can, if necessary, be installed sideways about 2…3 m from the mast itself.

When installing an antenna possible interference sources must be considered. Such interference sources are, for example:
mobile telephone network base station antennas
public telephone network base station antennas
television broadcast antennas
radio relay antennas
other radio modem systems
PC-related devices (approximately 5 m radius from antenna)

When ordering antennas we request you to note that antennas are always tuned to a specific frequency range. Simple antennas and antennas, which have been constructed of stacked yagi-antennas, are typically rather broadband. As the number of yagi-elements increases the frequency range becomes narrower.

When designing and installing a system it is advisable to prepare to test the system, and also to consider serviceability of the system. In particular cabling should be planned to allow easy access and to allow for maintenance. It is often practical to use long antenna cables, so that the radio modem can be installed far enough from the antenna itself to a location that is easily accessible.

The type of the antenna cable is dependent on the length of the antenna cable, and the following table can be used to select a suitable type:

Length	Type	Attenuation 10m/450MHz
<5m	RG58	3.0dB
0…20m	RG213	1.5dB
>20m	NK Cable RFF 1/2"-50	0.7dB
>20m	AirCom+	0.8dB*

*) AirCom+ cable is partially air insulated, so the use of this cable requires that the connection between the cable and the connectors are fully airtight.

If there is a line-of-sight path between the antennas a 6 dB power marginal is usually adequate. However, if the connection is built on the reflection and/or the knife-edge diffraction the path loss can vary even 20 dB depending on the weather conditions. In this case a short test can give a too positive result of the quality of the connection. Thus the height of the antennas and topographical obstacles must be surveyed with great care. From time to time a marginal connection can be used if the data transmission protocol is well prepared for this and the data transmission that occasionally slows down does not cause any problems to the system.

Vertical polarised antennas (antenna elements are in vertical position) are often used in radio systems. In a system between a base station and substations vertical polarisation is recommended. The radio modem antenna cannot be mounted on the same level as the other substation antennas in the same building. The best way to distinguish from the other antennas situated in the neighbourhood is to mount the antennas as far a part as possible from each other on the altitude level. The best result is generally obtained when all the antennas are in the same mast. With an extra ground plane between the antennas more isolation can be obtained between the antennas in the mast.

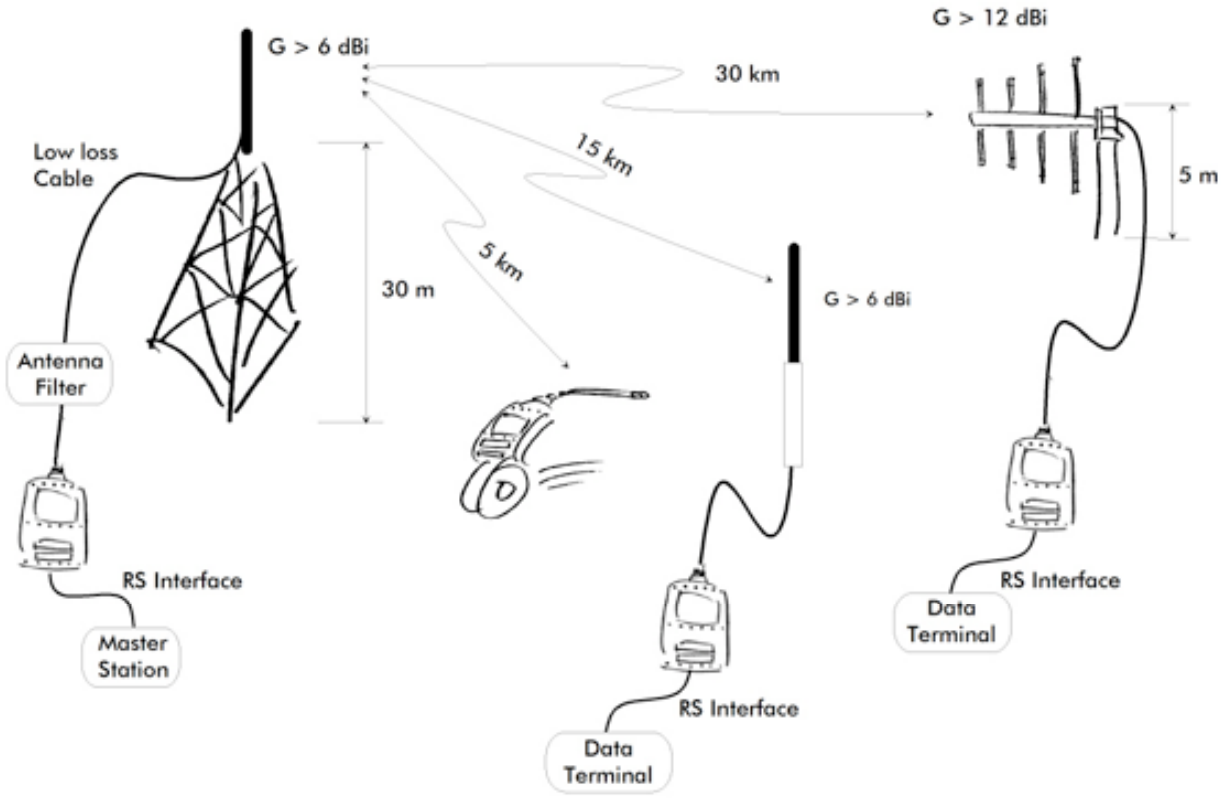
Horizontal polarisation can be used in data transmission between two points. With the polarisation attenuation more isolation is obtained to vertical polarised systems. The influence of the directional patterns of the antennas must, however, be taken into consideration. If an isolation to another interfering antenna is wanted with the horizontal polarised antennas there must be a good attenuation of the back lobe. In addition to this the interfering radiator should be situated behind the antenna.

When a system does not demand the use of an omni-directional antenna it is recommended that directional antennas are used e.g. two-element yagis in permanent external installations. Please note that as antenna amplification increases the setting of the direction of the antenna requires more attention.

Base stations in high places should be supplied with high-Q cavity filters. Please note that the higher the base station antenna, the larger the coverage area and in turn that the risk of interference is also increased.

SATEL recommends the use of a band-pass filter with a large Q in the antenna cable of the base station.

Example of an antenna installation: by using amplifying antennas (G = Gain) and by installing the antenna high, long connection distances can be realised using the SATELLINE-3AS-NMS radio modems.



15 CHECK LIST

The following points must be taken into account when installing and configuring a radio modem:

1. All operating voltages of all the equipment concerned must always be switched OFF before connecting the serial interface cable.

2. When considering the exact placement of a radio modem and/or its antenna, the following points must be taken into account to guarantee optimal results:

- The antenna should be installed in open space as far as possible from any possible sources of interference
- The radio modem should not be installed onto a strongly vibrating surface
- The radio modem should be installed in such a way as to minimise exposure to direct sunlight or excessive humidity.

3. To ensure reliable operation the voltage output of the power supply used must be stable enough and the current capability of the power supply must be sufficient.

4. The antenna must be installed according to instructions.

5. Settings of the radio modem must correspond to settings of the terminal.

6. All radio modems in the same system must be configured using same settings (radio frequency, channel spacing and data field length).

16 ACCESSORIES

16.1 RS-232 cables and adapters

Type	Description	Length	Note
NARS-1F	Interface adapter D15 m / D9 f, 650 mA fuse	-	including 2 m power supply cables and *Programming Mode* switch
NARS-1F-4A	As NARS-1F with 4A fuse for Epic only		
CRS-9	Interface cable D9 m / D9 f	2 m	-
CRS-1M	Interface cable D15 m / D25 m	2 m	including power supply cables
CRS-1F	Interface cable D15 m / D25 f	2 m	including power supply cables
CRS-2M	Interface cable D15 m / D9 m	2 m	including power supply cables
CRS-2F	Interface cable D15 m / D9 f	2 m	including power supply cables

Note! In the description, m=male, f=female connector type.

16.2 RS-485/422 cables and adapters

Type	Description	Length	Note
NARS-2	Interface adapter D15 m / screw terminals, 650 mA fuse	-	Screw terminals for RS-485/422 and power supply
NARS-2-4A	As NARS-2 with 4A fuse for Epic only	-	
CRS-PB	Interface cable D15 m / D9 m	2 m	including power supply cables

16.3 NMS cable

Type	Description	Length	Note
CRS-NMS	Interface cable D15 m / 2 x D9 f, from master modem to user system and NMS PC.	1.5 m	including power supply cables

16.4 RF-cables

Type	Description	Length	Note
CRF-1	Cable with TNC m/TNC f-connectors	1 m	RG58 (3 dB/10 m)
CRF-5F	Cable with TNC m/TNC f-connectors	5 m	RG58 (3 dB/10 m)
CRF-5M	Cable with TNC m/TNC m-connectors	5 m	RG58 (3 dB/10 m)
CRF-15	Cable with TNC f/TNC f 90-degree connector	15 cm	RG58 (3 dB/10 m)
RG213	Low loss cable	X	1,5 dB/10 m
AIRCOM+	Low loss cable	X	0,7 dB/10 m

16.5 Antennas

Type	Description
GAINFLEX 400-430	Half-wave antenna
GAINFLEX 430-470	Half-wave antenna
CA420Q	Sleeve fed quarter wave whip, 2dBi, 405–440 MHz
CA450Q	Sleeve fed quarter wave whip, 2dBi, 440-475 MHz
MINIFLEX 400-430	Helix antenna
MINIFLEX 430-470	Helix antenna
ANTENNA 869	Quarter wave antenna for 869 MHz modems

SATEL antenna selection includes also directional and/or omni-directional antennas. These can be supplied separately on request. Antennas are also available for the 869 MHz frequency band.

16.6 Filters and lightning protectors

If a radio modem system is installed in an environment that contains high-power transmitters or sources of radio frequency interference, it is highly recommendable to insert suitable filters between each radio modem and its antenna. If a station is installed to a location exposed to lightning, it is recommended to insert a lightning protector to the feed-line outside the protected zone. SATEL Customer Support can give guidance in the selection of suitable filters or protectors.

16.7 Power supplies

Type	Description
MAS-2	230 Vac/12 Vdc/1A
MAS-4	230 Vac/12 Vdc/5A

16.8 Batteries

Type	Description
SATEL-321	Weather proof battery pack with extended life time

16.9 Installation and enclosures

Type	Description
I-DIN	Installation plate for DIN rail mounting for 3AS NMS(d) modems
I-DIN Epic	Installation plate for DIN rail mounting for Epic
H-WP	Weather proof housing (IP54) for 3AS NMS(d) modems
H-WP-X2	Weather proof housing (IP54) for Epic modems
H-EX	Housing for potentially explosive environment, EEx d IIC T6 (also IP67)

17 APPENDIX A - ASCII CHARACTER TABLE

ASCII CHARACTER TABLE

D	H	A	D	H	A	D	H	A	D	H	A	D	H	A	D	H	A
0	0	NUL	43	2B	+	86	56	V	129	81		172	AC		215	D7	
1	1	SOH	44	2C	,	87	57	W	130	82		173	AD		216	D8	
2	2	STX	45	2D	-	88	58	X	131	83		174	AE		217	D9	
3	3	ETX	46	2E	.	89	59	Y	132	84		175	AF		218	DA	
4	4	EOT	47	2F	/	90	5A	Z	133	85		176	B0		219	DB	
5	5	ENQ	48	30	0	91	5B	[	134	86		177	B1		220	DC	
6	6	ACK	49	31	1	92	5C	\	135	87		178	B2		221	DD	
7	7	BEL	50	32	2	93	5D	]	136	88		179	B3		222	DE	
8	8	BS	51	33	3	94	5E	^	137	89		180	B4		223	DF	
9	9	HT	52	34	4	95	5F	_	138	8A		181	B5		224	E0	
10	A	LF	53	35	5	96	60	`	139	8B		182	B6		225	E1	
11	B	VT	54	36	6	97	61	a	140	8C		183	B7		226	E2	
12	C	FF	55	37	7	98	62	b	141	8D		184	B8		227	E3	
13	D	CR	56	38	8	99	63	c	142	8E		185	B9		228	E4	
14	E	SO	57	39	9	100	64	d	143	8F		186	BA		229	E5	
15	F	SI	58	3A	:	101	65	e	144	90		187	BB		230	E6	
16	10	DLE	59	3B	;	102	66	f	145	91		188	BC		231	E7	
17	11	DC1	60	3C	<	103	67	g	146	92		189	BD		232	E8	
18	12	DC2	61	3D	=	104	68	h	147	93		190	BE		233	E9	
19	13	DC3	62	3E	>	105	69	i	148	94		191	BF		234	EA	
20	14	DC4	63	3F	?	106	6A	j	149	95		192	C0		235	EB	
21	15	NAK	64	40	@	107	6B	k	150	96		193	C1		236	EC	
22	16	SYN	65	41	A	108	6C	l	151	97		194	C2		237	ED	
23	17	ETB	66	42	B	109	6D	m	152	98		195	C3		238	EE	
24	18	CAN	67	43	C	110	6E	n	153	99		196	C4		239	EF	
25	19	EM	68	44	D	111	6F	o	154	9A		197	C5		240	F0	
26	1A	SUB	69	45	E	112	70	p	155	9B		198	C6		241	F1	
27	1B	ESC	70	46	F	113	71	q	156	9C		199	C7		242	F2	
28	1C	FS	71	47	G	114	72	r	157	9D		200	C8		243	F3	
29	1D	GS	72	48	H	115	73	s	158	9E		201	C9		244	F4	
30	1E	RS	73	49	I	116	74	t	159	9F		202	CA		245	F5	
31	1F	US	74	4A	J	117	75	u	160	A0		203	CB		246	F6	
32	20	SP	75	4B	K	118	76	v	161	A1		204	CC		247	F7	
33	21	!	76	4C	L	119	77	w	162	A2		205	CD		248	F8	
34	22	"	77	4D	M	120	78	x	163	A3		206	CE		249	F9	
35	23	#	78	4E	N	121	79	y	164	A4		207	CF		250	FA	
36	24	$	79	4F	O	122	7A	z	165	A5		208	D0		251	FB	
37	25	%	80	50	P	123	7B	{	166	A6		209	D1		252	FC	
38	26	&	81	51	Q	124	7C	|	167	A7		210	D2		253	FD	
39	27	'	82	52	R	125	7D	}	168	A8		211	D3		254	FE	
40	28	(	83	53	S	126	7E	~	169	A9		212	D4		255	FF	
41	29	)	84	54	T	127	7F		170	AA		213	D5				
42	2A	*	85	55	U	128	80		171	AB		214	D6				

18 APPENDIX B - DELAYS

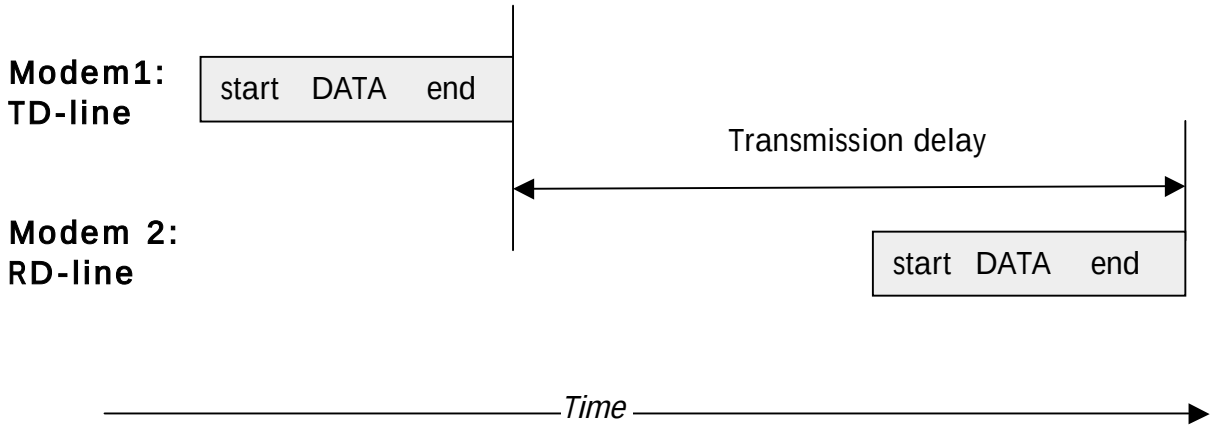
18.1 Functional delays

Table 18.1. **Functional delays**

Function	Delay (ms)
Wakeup time from STAND-BY to ON (controlled by DTR line)	<500
Serial interface, turn-around time of RS-232	0
Serial interface, turn-around time of RS-485	<1
Intercharacter delay	Max. 2-3 characters

18.2 Transmission related delays

The tables on the next pages show the typical values of the transmission delay using different sized data messages. The transmission delay is specified from the end of the transmission to the end of reception on the serial interface:



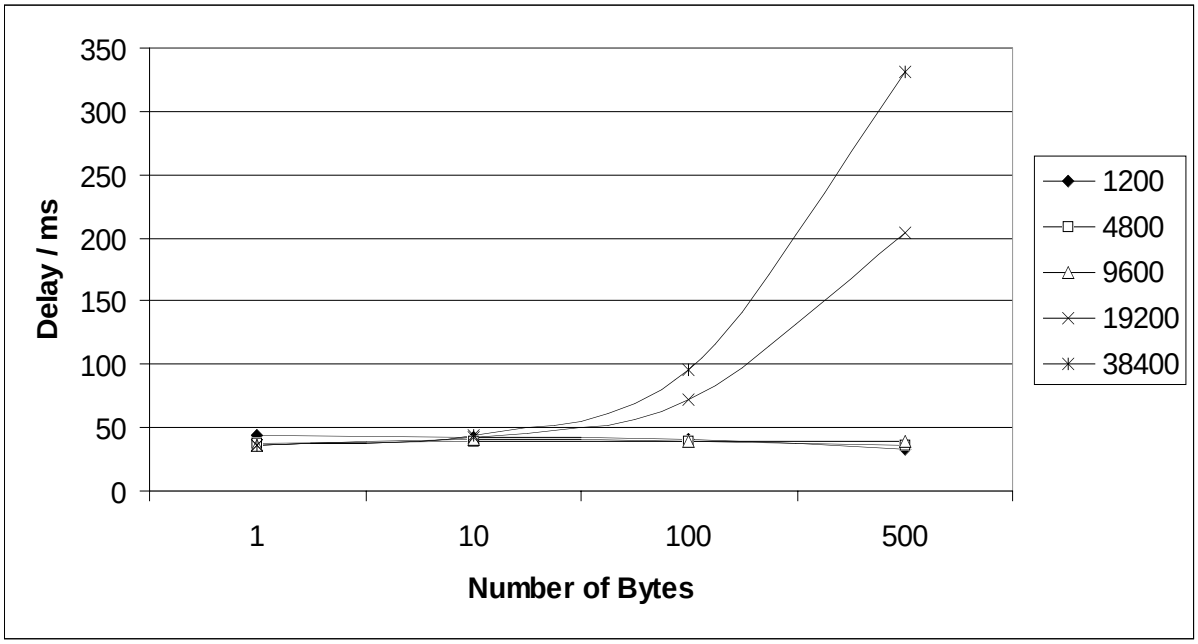
18.2.1 Transmission delays - 12.5 kHz channel, FEC OFF, no NMS

Table 18.2. **Transmission delays with the following settings:**

- **12.5 kHz channel spacing**
- **FEC OFF (Forward Error Correction function OFF)**
- **No NMS information included**

Transmission delays are in milliseconds (10% marginal) vs. the size of a message (bytes) to be transmitted.

Data speed	*1 byte*	*10 bytes*	*100 bytes*	*500 bytes*
1200 bps	48,8 ms	47,0 ms	45,5 ms	38,3 ms
4800 bps	42,8 ms	42,9 ms	43,4 ms	41,0 ms
9600 bps	41,6 ms	43,8 ms	44,4 ms	44,0 ms
19200 bps	40,4 ms	47,4 ms	76,4 ms	208 ms
38400 bps	40,8 ms	48,8 ms	101,2 ms	332 ms



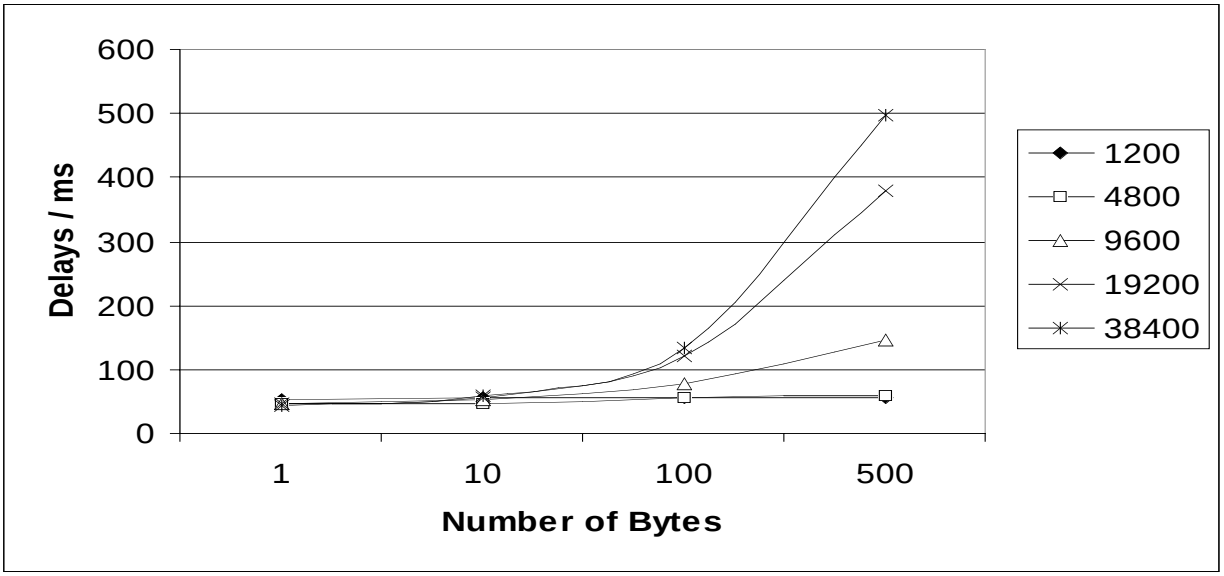
18.2.2 Transmission delays - 12.5 kHz channel, FEC ON, no NMS

Table18.3. **Transmission delays with the following settings:**

- **12.5 kHz channel spacing**
- **FEC ON (Forward Error Correction function ON)**
- **No NMS information included**

Transmission delays are in milliseconds (10% marginal) vs. the size of a message (bytes) to be transmitted.

Data speed	*1 byte*	*10 bytes*	*100 bytes*	*500 bytes*
1200 bps	58,2 ms	61,4 ms	58,6 ms	57,0 ms
4800 bps	51,4 ms	52,0 ms	59,2 ms	59,5 ms
9600 bps	50,4 ms	58,6 ms	80,8 ms	146 ms
19200 bps	50,0 ms	61,2 ms	114,8 ms	376 ms
38400 bps	49,4 ms	63,4 ms	137,2 ms	502 ms



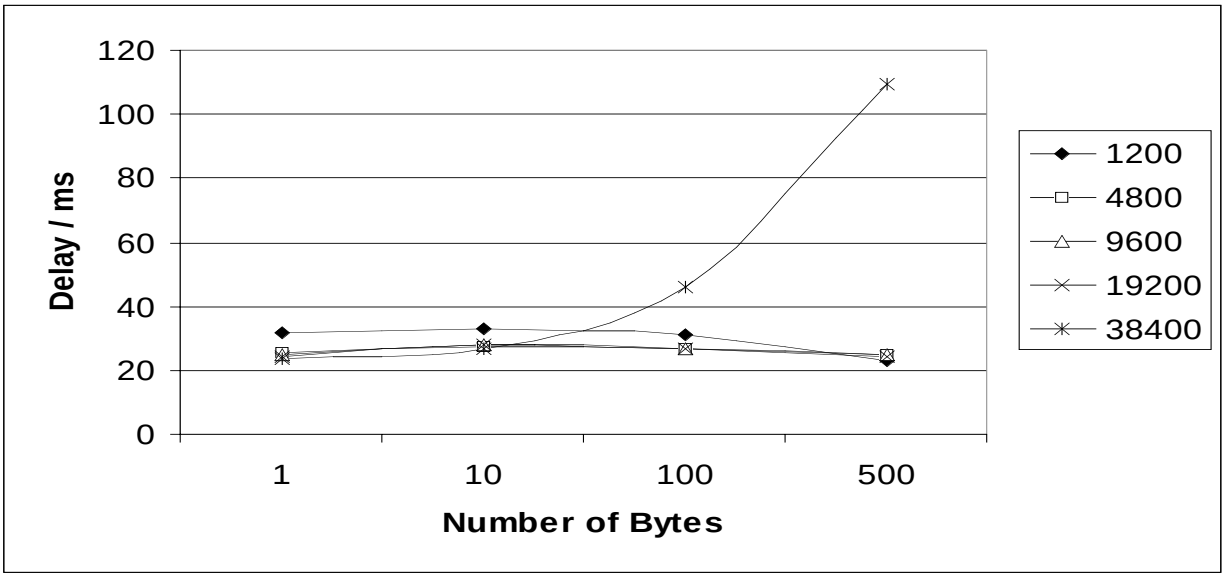
18.2.3 Transmission delays - 25 kHz channel, FEC OFF, no NMS

Table 18.4. **Transmission delays with the following settings:**

- **25 kHz channel spacing**
- **FEC OFF (Forward Error Correction function OFF)**
- **No NMS information included**

Transmission delays are in milliseconds (10% marginal) vs. the size of a message (bytes) to be transmitted.

Data speed	*1 byte*	*10 bytes*	*100 bytes*	*500 bytes*
1200 bps	33,9 ms	32,0 ms	31,1 ms	23,3 ms
4800 bps	27,7 ms	26,6 ms	27,0 ms	24,6 ms
9600 bps	26,8 ms	26,7 ms	27,2 ms	25,0 ms
19200 bps	26,5 ms	27,3 ms	26,6 ms	24,8 ms
38400 bps	26,7 ms	29,4 ms	43,6 ms	110 ms



18.2.4 Transmission delays - 25 kHz channel, FEC ON, no NMS

Table 18.5. **Transmission delays with the following settings:**

- **25 kHz channel spacing**
- **FEC ON (Forward Error Correction function ON)**
- **No NMS information included**

Transmission delays are in milliseconds (10% marginal) vs. the size of a message (bytes) to be transmitted.

Data speed	*1 byte*	*10 bytes*	*100 bytes*	*500 bytes*
1200 bps	35,5 ms	34,1 ms	38,3 ms	34,2 ms
4800 bps	30,2 ms	28,1 ms	30,6 ms	28,2 ms
9600 bps	29,4 ms	31,7 ms	33,2 ms	32,8 ms
19200 bps	28,8 ms	34,8 ms	46,2 ms	78,0 ms
38400 bps	28,5 ms	36,8 ms	61,2 ms	192 ms